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GOVERNMENT TELEGRAPHS.

THE advantages which accrue from the exclusive Government control of a system like that of the telegraph have been often questioned, and it is but little likely that all parties will be agreed upon the point. There is much to be said on both sides. In the case of the telegraph system in this country the Government holds a monopoly, and monopolies are always bad, say some, because they lack the stimulus to which competition gives rise. If it were a case of a commercial and not a Government system, the argument would have far more force than it has actually. A system carried on by private individuals or by a company has for its prime object the payment of good dividends upon the capital invested in the concern, and the convenience of the public is not considered except in so far as such consideration may tend to promote the object in view, viz., a good return upon the capital sunk. In regard to the telegraph system of this country, the extension of the means of carrying out the work, which took place on the transfer of the various systems to the State, was most marked and has continued to be so up to the present time. Consistent with the expenses not exceeding the receipts, the convenience of the public has been consulted in many ways, and notably in the opening of offices in country districts where the amount of remunerative work is very small. Such extensions were not, and were not likely to be, contemplated when the telegraphs were in the hands of the companies; they would not pay, and that was the end of the matter. But now with regard to another point—it has been more than once stated that the effect of the Government monopoly has been to stifle invention; and quite recently our American contemporary, the *Electrical World*, contrasts what has been done respectively in America and in England in the following words: "The English Government last Thursday completed their 16th year of monopoly of the telegraph lines (February 4th, 1870). They have little improvement to show for their 16 years of exclusiveness, except their record of a determined effort to crush out the telephone. On the other hand, during that period we have tossed off the duplex, the quad, the telephone, and a few other trifles that are only born of or nurtured by a spirit of keen competition." Now it is, perhaps, hardly necessary to restate the well-known fact that neither the duplex nor the quadruplex is exclusively an American invention. The general principles of both are now over 30 years old; the apparatus as at present worked are improvements on the original idea, most marked improvements undoubtedly, but still improvements only. As regards the quadruplex, it was found necessary to entirely remodel the apparatus from the American patterns; had the latter only been available we believe that there would not now be a single set in use in this country. The statement that the Postal Department "have little improvement to show for their 16 years of exclusiveness" is very far from being correct, but is due to the ignorance of the writer, a not unnatural ignorance, perhaps, seeing that the many improvements effected are not regularly made known through the scientific journals. It may not be amiss to mention the fact that the Wheatstone automatic instrument which at the time of the transfer of the telegraphs to the State was only capable of working at a speed of 50 to 60 words a minute, has been so far improved by the Postal engineers as to enable a speed of 450 words per minute to be attained. Of the numerous small but important improvements which have been "tossed off" it is unnecessary to speak, but we emphatically repeat that they exist though they are not generally known to the public. Whether under the old competition system greater strides would have been made is, of course, a question which it is impossible to answer, but that under Government control invention has practically ceased is not proved, in fact, it is an incorrect statement, despite the lamentations of many disappointed inventors.

THE WORK PERFORMED IN TELEGRAPHING.

By W. MOON.

WHEN work of any kind is performed energy is expended, and this expenditure takes place in two or more forms. In telegraphing a message energy is expended in at least four different forms. Thus, in sending a message on a sounder circuit, human labour is required to work the key, the battery performs work throughout the circuit, work is performed in the movement of the receiving apparatus, and finally energy is expended in producing the sound. Again, if the message is signalled automatically, mechanism is used at both ends of the circuit, and finally the message might be perforated with pneumatic apparatus. The energy expended in these various forms may be expressed in one common measure, and the amounts of energy expended in each form, and in each operation, may be calculated with tolerable accuracy.

In all the following results I give the energy in foot pounds expended in telegraphing the average word. An average word contains 5·75 dashes and 8 dots; or is equal to about 14 signals on a key and 20 depressions on a perforator.

Firstly, as to human labour. The net work performed by the clerk may be determined by multiplying the number of signals by the play of the key by the tension of the spring at the point of application. Thus, the play of a single current key is about $\frac{1}{64}$ of an inch and the tension of the spring 6 ozs. Therefore the net work performed in sending the average word is

$$\frac{14 \times 6}{64 \times 12 \times 16} = \frac{1}{153} \text{ foot lb.}$$

In a similar manner the net work performed with a double current key having $\frac{1}{12}$ inch play is

$$\frac{14 \times 6}{12 \times 12 \times 16} = \frac{1}{27} \text{ foot lb.}$$

The tension of the springs of single-needle instruments is somewhat greater; say 8 ozs., and the play about $\frac{1}{12}$ inch. Then the work performed is

$$\frac{14}{12 \times 12 \times 2} = \frac{1}{20} \text{ foot lb.}$$

The play of the pedals of a perforator is about $\frac{1}{3}$ inch, and the mean tension of the spring about $1\frac{1}{4}$ lbs.; therefore the work performed in perforating a word would be about

$$\frac{20 \times 5}{3 \times 12 \times 4} = \frac{2}{3} \text{ foot lb.}$$

All of these net expenditures of energy would only represent a small portion of the labour of manipulating; since the greater portion of the labour of manipulating would consist in the movement of the arm itself, and in the fatigue of keeping the muscles contracted when no external work is performed.

It will be observed that the net labour of perforating a word is about 100 times greater than the labour of signalling a word on a single current key; but the gross labour, though much greater, would not, of course, be 100 times as great. The fatigue experienced in manipulating a double-current key is but very little more than that experienced with a single-current key.

Next, as to the work performed by the battery. The energy expended by the battery may be calculated from the formula

$$\frac{\text{E } c \ t}{1{,}325} \text{ foot lbs.,}$$

where E is the electromotive force in volts and c the current in milliampères, and t the time in seconds.

The work performed by the battery would vary with the length of the circuit. As an example, suppose a word sent at the rate of 20 words a minute with an E.M.F. of 50 volts and a current of 20 milliampères, then the energy expended by the battery would be

$$\frac{50 \times 20 \times 3}{1{,}325} = 2\frac{1}{4} \text{ foot lbs.}$$

This energy would be expended throughout the circuit, principally in the form of heat. The amount of heat generated in the coils of the receiving relay may be calculated from the formula

$$\frac{c^2 \text{ R } t}{1{,}325{,}000} \text{ foot lbs.,}$$

where c is in milliampères and R in ohms. For example, suppose one half of the current sent in the last instance reached the receiving station, then the energy expended in heat in the relay coils would be

$$\frac{10^2 \times 400 \times 3}{1{,}325{,}000} = \frac{1}{11} \text{ foot lb.}$$

The amount of energy expended in heat in the coils of the sounder may be calculated with the aid of the last formula. It equals about $\frac{1}{2}$ foot lb. per word.

The energies expended by the movement of the armature of the sounder and the tongue of the relay may be calculated in the same manner as the energy expended in manipulating the key, by multiplying the force with which the armature or tongue is actuated, by the distances through which they are moved.

The force which the coils of a standard relay exert upon the tongue is equal to $\frac{c}{128}$ oz. where c is in milliampères; and the play of the tongue at the contacts is about $\frac{1}{200}$ inch. Therefore the energy expended by the motion of the tongue of the relay in signalling a word with 10 milliampères would be

$$\frac{10 \times 14 \times 2}{16 \times 128 \times 200 \times 12} = \frac{1}{18000} \text{ foot lb.}$$

About one-tenth of this energy would be expended in overcoming the friction at the pivots; the remainder of the energy being expended in the blows of the tongue against the screws at the contact points. Although the amount of energy expended at each blow of the tongue against the contact screw, is only $\frac{1}{3000000}$ foot lb., yet this minute amount of energy is expended in four different forms, namely: the friction of the tongue at the pivots, the heat generated by the impact of the contact points, the molecular vibrations set up in the instrument by the impact, and the sound produced. And yet the sound produced is sufficiently great to be heard at several yards distance, in a quiet room.

The force which the coils of a sounder exert upon its armature varies with the distance. In a well adjusted sounder the pull upon the armature is about 2 lbs. when the armature is "up," and about 6 lbs. when the armature is "down"; therefore the mean pull may be taken as $3\frac{1}{2}$ lbs. If the play at the armature is taken as $\frac{1}{128}$ inch, then the energy expended by the armature in signalling a word will be

$$\frac{7 \times 14}{2 \times 128 \times 12} = \frac{1}{30} \text{ foot lb.}$$

About five-sixths of this amount of energy is expended when the armature is attracted; the remaining energy being stored up in the increased tension of the spring, and afterwards expended when the spring pulls away the armature from the electro-magnet. It is probable that only a small portion of this $\frac{1}{30}$ foot lb. is transformed into audible sound, the remaining portion being mostly expended in producing molecular vibrations in the sound box and desk. These vibrations may be readily felt by resting the fingers gently on the desk.

The energy expended by the motion of the sounder's armature, is derived, of course, from the local battery. Thus, when the armature of the sounder is moving towards the coils, it sets up in the circuit an opposing E.M.F., which reduces the current flowing in the circuit; so that the energy expended in the circuit as heat and that absorbed by the opposing E.M.F., *i.e.*, the movement of the armature, are, together, equal to the consumption of energy in the local battery.

It will be observed that the energy expended by the motion of the armature is about one-fifteenth of the consumption in the battery; so that the motion of the armature must produce an appreciable effect upon the current flowing in the circuit. But in the case of the relay the motion of the tongue would produce no perceptible effect upon the current, since the energy expended by the motion of the tongue would be about $\frac{1}{3000}$ of the consumption of energy in the battery.

When a message is signalled automatically energy is expended by the transmitter in driving the slip forward and sending the signals. The mechanism of the transmitter is driven by a $\frac{1}{2}$ cwt., which falls through a distance of 2 feet. The transmitter will run 80 feet of slip, that is, about 400 words, each time it is wound up; therefore the energy expended in running one word is

$$\frac{112}{400} = \frac{1}{4} \text{ foot lb.}$$

In a similar manner the energy expended by the receiver's mechanism for each word received, is found to be about $\frac{1}{6}$ foot lb.

Of all the different forms in which energy is expended in connection with telegraphy, pneumatics is by far the most wasteful. Thus, to produce a cubic inch of compressed air, at a pressure of 12 lbs. to the square inch, requires 1·6 foot lbs., and to "punch" a word about 20 cubic inches of compressed air is required, that is, about 32 foot lbs.

A Wheatstone's A B C instrument requires about $\frac{1}{2}$ foot lb. for each turn of the handle, or about $\frac{1}{60}$ foot lb. per signal sent; so that, roughly speaking, a gross performance of about 4 foot lbs. per word is required.

Batteries for Scarf Pins.—A New York correspondent informs us that mercury and potash batteries are among the best for use with electrical scarf pins. These batteries are enclosed in hard rubber cases which can be easily carried in the pocket.

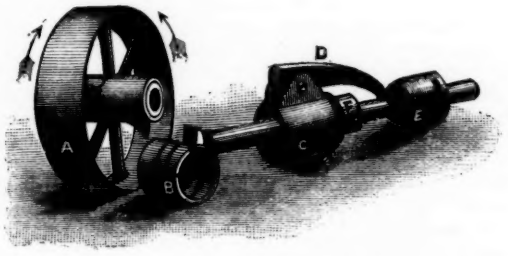
BARNES'S FRICTION-CLUTCH PULLEY AND CUT-OFF COUPLING.

THE Barnes friction pulley and cut-off coupling, which is represented in the accompanying engraving, is described in the New York papers as one of the simplest and most effective friction pulleys known.

In the cut A represents the pulley; B, the spiral spring or sleeve; C, the cylinder carrying the operating lever, and affixed firmly to the shaft at F; E, a movable thimble with a circular slot, in which the fork for shipping is fitted; and beneath C is a screw for regulating the amount of friction.

The operation is as follows: The spiral spring is bored to fit nicely on the turned hub of the pulley, A, the whole being enclosed by the cylinder, C, through a slot in which the projection, cast on the sleeve, passes; the tapered end of lever, D, engages with this, and by sliding the thimble forward or backward, in case two pulleys are used, the spiral spring (which is prevented from turning by the adjustable screw) is tightened on the hub of the driving pulley with any required amount of force, and as the friction increases as the square of the number of coils used in the spiral spring, the driving power is limited only by the strength of materials.

When used as a cut-off coupling, a hub alone is used in place of the pulley.



Amongst its advantages it may be remarked that it does away entirely with a fast and loose pulley and shifting belt, saving one pulley and reducing the width of face required in the driving pulley; saves the wear on the belt occasioned by shifting, and renders the use of a narrower belt possible through the increased tension, which the fact of its not being shifted admits. It gives the workman absolute control over his machinery, enabling him to start or stop it instantly, thus adding to its efficiency and lessening the chance of damage to valuable machinery in case of an accident.

It has no wood or leather in its construction, being made wholly of metal, has no wearing surfaces to be replaced, is noiseless in its operation; where a reverse motion is required, it does its work speedily and effectively.

For electric light plants in factories and mills it is very valuable. It enables the motive power for the dynamos to be taken directly from the main shaft, without resorting to the dangerous experiment of shifting a belt or shutting down while the connection is being made, and will, in many cases, obviate the necessity of employing a special engine for running the dynamos.

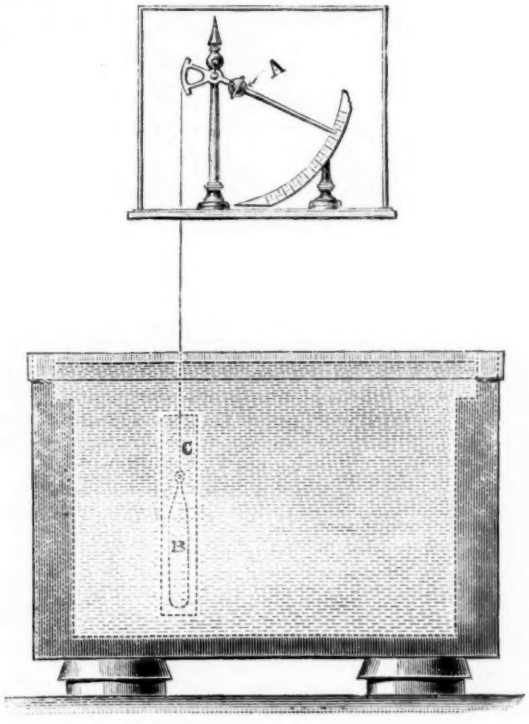
A CHARGE AND DISCHARGE INDICATOR FOR SECONDARY BATTERIES.

WE give below a description of the "Elwell-Parker" secondary battery gauge, or charge indicator, for automatically closing the charging circuit when the cells are exhausted, and breaking it when they are fully charged; also for continuously showing the condition of the charge, and signalling it by a bell or otherwise.

Prof. Forbes at the Society of Arts drew attention to the necessity for a reliable indicator, actuated by the change in density of the liquid for automatically working a switch, and he was not aware that any such was in use; but then Prof. Forbes is noted for overlooking, or not being acquainted with, the labours of previous workers in electrical science.

This instrument, designed upon the principle of the hydrostatic balance, and patented by Mr. Thos. Parker, has been used in connection with the Elwell-Parker accumulators during the past two years and, we are told, with perfect success. It is unaffected by the level of the solution, and does not require a special cell.

It consists of a vertical brass pillar, from which projects a horizontal arm, carrying by two silk cords the beam, at one end of which is the segment of a wheel, the axis of the beam forming the centre, and at the other end is an ivory pointer and an adjustable balance weight.



A glass bulb, B, hermetically sealed and loaded so as to *just* sink in the solution when at its greatest density, is suspended in the centre of the cell by a platinum wire attached within the gauge case to a silk cord hanging from the segment on the beam. The gauge, entirely enclosed in a glass case, is placed upon a shelf directly above the cell, so that the glass bulb hangs in the solution without touching the plates.

It will be at once seen that, as the battery is being charged and the specific gravity of the solution increases, the bulb, B, will rise, and the angle formed by the arm bearing the balance weight, A, with the vertical pillar will become more acute until the pointer reaches the bottom of the scale, when a cross bar formed by a fine piece of platinum wire at the end of the pointer comes into contact with two upright platinum terminals and so closes the circuit, either of an electro-magnetic switch (for automatically cutting the battery out of the general charging circuit), or of an electric bell in the engine house (to show that the charging is complete), or where a gas engine is used to cut off the gas and so stop the engine.

A similar contact may be made when the cells are exhausted (to any desired extent) and the charging circuit thrown in again, or a bell sounded, by the pointer reaching the top of the scale.

As the capacity of a secondary battery, when always discharged in series, depends upon that of the weakest cell it contains, and as every cell will require exactly

the same amount of current to recharge it, a single indicator placed over any cell is all that is required.

We should be glad to know whether this apparently reliable instrument has been used in any electric light installation outside the laboratory or works, also whereabouts in the cell the apparatus is placed. We were under the impression that the plates in secondary batteries were too close together to get such an hydrometer as that we have described in between; in addition, are not the Elwell-Parker plates separated by grids of ebonite or other insulating material? It may be said, in reply, that it is placed at the end or corner of a cell, but does not the specific gravity of the liquid change more rapidly between the plates than where no action is going on, and does not the specific gravity at the bottom of the cell differ from that at the top? If, on the other hand, one cell of a series is made somewhat more roomy to allow the hydrometer freedom of movement without touching the plates, would it not be necessary in practice to make all the cells of similar dimensions in order that the instrument might be shifted to that cell which may at the time be weakest?

THE ELECTRIC LIGHTING OF LIGHT-HOUSES.

THE great utility of the illumination of the coasts, both on account of the security of navigators and for the development of the maritime power of the country has, writes M. Felix Lucas in *Comptes Rendus*, for a long time attracted the attention of engineers and physicists, and has justly excited their emulation in search of improvements. More than any other nation France has contributed to the successive improvement of the appliances for lighting up lighthouses. For the last twenty-five years the discoveries made in the department of electricity have opened up a new field of research.

The lighthouses on the coast of France at present illuminated by the arc light are those of Dunkerque, Calais, Gris-Nez, La Canche, La Hêve, the Baleines and Palmyre. A great number of other lighthouses of the first rank at present lighted with petroleum are about to be converted into electric lighthouses.

In a memoir on "Magneto-electric machines and the voltaic arc in lighthouses," inserted in July, 1885, in the *Annales des ponts et Chaussées*, I indicated the laws and the working conditions of these appliances. We employ in all a force of 4 horse-power to produce 450 Carcel burners, thus obtaining 112 Carcels per horse-power. As the electric current is 55 ampéres and the resistance of the arc 0·43 ohm, the difference of potential between the two carbon points is 23·65 volts and the electric energy amounts to 1,300 watts. Hence, for the 4 horse-power employed the arc absorbs only 1·76 horse-power, the rest is expended on the transmission of power by belting, the rotation of the magneto-electric machine, the internal energy of this machine, and the external current corresponding to the transmission from the machine to the arc.

In fine, the voltaic arc presents, compared with petroleum lamps, two advantages of the first order for use in lighthouses, that is to say, the luminous power and the diminution of the cost of the unit of light. But it is, unfortunately, open to some criticisms, the chief of which relates to the capricious instability of its light. If we observe attentively one of these powerful foci we perceive at once that the great light does not come from the blueish flame which, properly speaking, constitutes the voltaic arc. It comes from the points of carbon raised to incandescence by the enormous elevation of their temperature. The flame of the arc is rather a screen than a focus. It absorbs more light than it gives out. The unsteadiness of the light noticed is due not so much to the variation in the mean difference of the points as to the continual displacement of this screen around the carbon, and the capricious and continual rotation of the incandescent zones around the points. This defect is so inherent in the very nature of the voltaic arc that its complete removal seems unattainable.

But as soon as it is incandescence, and not the combustion or the transfer of the particles of carbon from one pole to the other, which constitutes the main cause of the light, cannot we expect incandescence in a vacuum to furnish a focus as powerful as the voltaic light? It seems to me that in this direction must be sought the future solution of the problem of the electric lighting of lighthouses, and I have for some months studied in this direction.

The conditions which I have imposed upon myself, by reason of the very nature of the object sought, are the following:

1. The luminous focus must present the form of a surface of rotation having a vertical axis, for the light must be equally distributed in all azimuths.

2. We must have recourse to currents of quantity, and to an incandescent body of low resistance, obtaining many watts with few volts, so as to give power to the luminous focus without producing at the same time a lightning-like, or even dangerous tension.

3. The incandescent body can only be of carbon, because it is the only substance which can support excessive temperatures without fusion or volatilisation.

In a memoir inserted in the *Comptes Rendus* of June 8th, 1885, I made known the law which links the luminous intensities to those of the currents traversing an incandescent carbon. We may obtain 400 carcels with a current of 170 ampères and a resistance (of the incandescent body) of 0·04 ohm, or, in other terms, with a tension of 7 volts and an energy of 1,200 watts. In these conditions the luminous unit does not require, for the incandescent part of the circuit, a mechanical work greater than what it requires at present with the use of the voltaic arc. I have estimated the temperature of the luminous carbon at about 4,000° C., and I have found that the carbon is neither melted nor volatilised.

We know that in incandescence lamps there is produced in course of time a carbonaceous deposit upon the inner surface of the glass globe. This gradual decrease of transparence would be especially injurious for powerful incandescence foci. I have endeavoured to determine the true cause, and my experiments prove that it consists in the presence of molecules of oxygen within the lamp. We find, in fact, that the rate of increase of the deposit is in direct relation with the pressure of the internal gas. We should arrive at an infinite slowness, or, in other words, at the cessation of the deposit if we could obtain and preserve an absolute vacuum within the glass globe. A molecule of oxygen not removed combines with the carbon near its junction with the metallic conductor a region in which the temperature cannot reach the melting point of the conductor. There is thus formed a molecule of carbonic oxide. This molecule, then, coming in contact with the incandescent portion, the temperature of which is high enough to produce dissociation, projects the carbon against the inner surface of the glass globe and leaves the oxygen at liberty to combine again.

The realisation of an absolute vacuum in an incandescence lamp is rendered particularly difficult by the tenacity with which carbons and metals retain the gases which they have stored up in their pores. Under the influence of the rise of temperature caused by the passage of the electric current these gases escape at first to a great extent, but the liberation soon becomes so slow that we seem in presence of a phenomenon obeying an asymptotic loss. This loss, which I have clearly established, shows that every apparatus intended to produce the incandescence light on a large scale must be furnished with an absorber capable of constantly storing up, at every point of time in the working of the lamp, the gases which escape in slight quantities from the heated carbons and metals.

It must be remarked, on the other hand, that the gases liberated during the passage of the current and

not removed from the apparatus are reabsorbed by the carbons when they become cold. In consequence the presence of a small quantity of gas in an incandescence lamp compels the carbons to periodic disengagements and re-absorptions. Hence a mechanical work is imposed on its molecules, which is one of the principal causes of the destruction, sooner or later, of the lamp. To give a powerful incandescence lamp the conditions requisite for lasting it must be freed from the dangerous influence of even the most rarified gases. I have found that this difficulty may be overcome by the use of absorbent appliances.

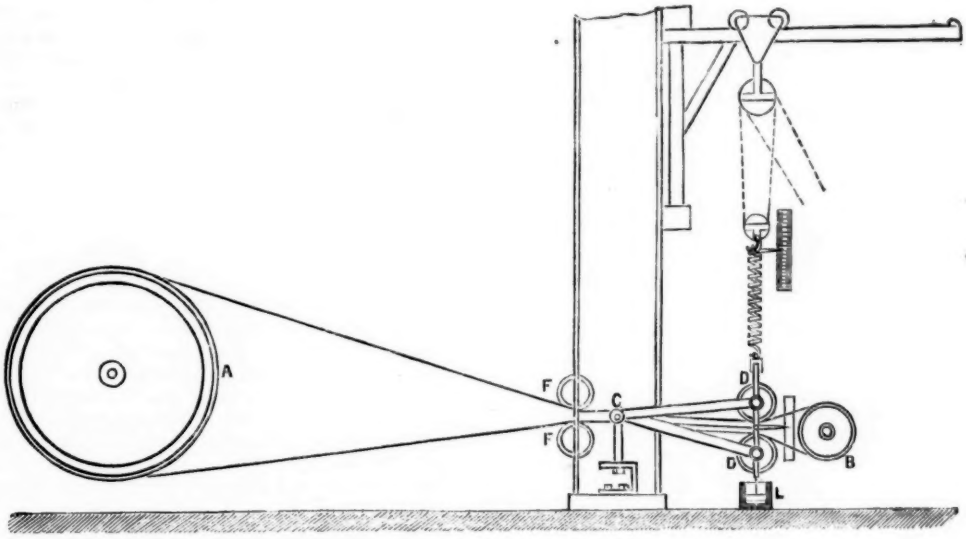
DYNAMO TESTING.

ON Saturday last, at the invitation of Messrs. Mather and Platt, a party of gentlemen met at the Salford Ironworks to witness a new method of determining the efficiency of conversion from mechanical to electrical energy by dynamo machines. After making a tour of the various departments of the extensive works, including the large machine shop and foundry, in which men were busy at work upon various operations of a most interesting character, the party were led up to the locality of the electrical operations, now a very important branch of Messrs. Mather and Platt's vast business. Here dynamos were seen of various sizes, and in every stage of manufacture; the centre of interest, however, was the pair of Edison-Hopkinson dynamos, which were coupled up for the purpose of illustrating the new method of measurement. The following statement was supplied to those present as a description of the operations:—"The method hitherto adopted for determining the efficiency of conversion from mechanical to electrical energy by dynamo machines has consisted in a direct measurement of the power transmitted to the dynamo through the driving belt by a transmission dynamometer, and the determination of the electrical power developed outside the machine. The latter portion of the experiment presents no difficulties, and even when large powers are dealt with a high degree of accuracy is easily attainable; but all who have used a transmission dynamometer know that it is exceedingly difficult to obtain accurate results, even when the utmost precautions are taken, and the difficulty is vastly increased when large powers have to be dealt with. If the power transmitted amounts to 50 horse-power, or upwards, probably few experimenters would undertake to guarantee the accuracy of the observation within limits of even 2 or 3 per cent.; and the determination of the efficiency will be erroneous precisely in proportion to the error in the dynamometer. Probably, therefore, no efficiency experiments hitherto made on a large scale can be regarded as having any certainty of accuracy within at least 3 per cent.

"During the discussion of the paper on 'Dynamo-Electric Machines,' recently read by Mr. Kapp, before the Institution of Civil Engineers, Dr. John Hopkinson suggested an entirely new method by which the efficiency of conversion can be determined with great ease, and which is not open to the above objection. The method also throws light upon other points of great interest, and especially on the much-discussed question as to the relation between the dynamo when used as a generator and motor respectively.

"Let two dynamos, approximately equal in dimensions and power, have their shafts coupled by a suitable coupling, which may serve also as a driving pulley; and let the electrical connections between the dynamos be made so that the one drives the other as a motor. If the combination be driven by a belt passing over the coupling pulley, the power required to be transmitted by the belt is the waste in the two dynamos and the connections between them. Moreover, by suitably varying the magnetic field of one of the dynamos, the power passing internally between the two machines can be adjusted as desired. If, then, the electrical power given out by the generator is measured, and also the power transmitted by the belt, the efficiency of the combination can be at once determined. The beauty and advantage of the arrangement lies in the fact that the measurement, which presents experimental difficulties, is of a small quantity, viz., the power transmitted by the belt. Consequently, even a considerable error in the determination has but a small effect on the ultimate result. On the other hand, the measurement of the large quantity involved, viz., the electrical power passing between the two machines, can without difficulty be made with great accuracy. Assume, for example, that the generator dynamo gives 50 horse-power, and the motor provides 40 horse-power of this amount; then the driving belt has to supply 10 horse-power only, and an error of 3 per cent. in the measurement of this quantity would cause an error of only 0·6 per cent. in the final result. The method thus obviates entirely the objections to other methods formerly employed, and has at the same time the advantage that the actual mechanical power transmitted to the machines is small, and therefore more readily dealt with by the dynamometer. In fact, an error of ½ per cent. may be considered as the extreme limit, if ordinary precautions are taken.

"The two machines experimented on were of the well-known Edison-Hopkinson type, with all the latest



improvements introduced by Dr. John Hopkinson and Messrs. Mather and Platt. They are similar in all their dimensions and winding, and are each intended for a normal output of 110 volts, 320 ampères, at a speed of 780 revolutions per minute. They are both shunt wound only, and have solid wrought iron magnet cores and field pieces. The commutators are of copper, insulated with mica, with 40 bars. The general arrangement of the dynamometer is shown in the diagram.

"A is the driving pulley of the engine, B the driven coupling of the dynamos; D, D, are the guide pulleys of the dynamometer turning about the fulcrum, C, and supported by a spring, the tension of which is read by a pointer against a fixed scale, when the index of the dynamometer is brought to its fiducial mark. The potential between the terminals of the generator is measured by a Thomson's graded galvanometer, previously carefully standardised by a Clark's cell, and the current is measured by passing it through a known resistance; the difference of potential between the ends of the resistance is determined by Poggendorff's method by direct comparison with the Clark's standard cell.

"The resistance of the armatures and magnets of the two machines are as follows:—

Generator ...	Armature	0·009947	ohms.
	Magnets	16·93	,,
Motor ...	Armature	0·009947	,,
	Magnets	16·44	,,

"The results of one of a large series of experiments giving entirely concordant results are as given below:—

E.M.F. at terminals of generator	=	110·12 volts.
Current	=	358 ampères.
Current through generator magnets	=	6·50 ,,
Current through motor magnets	=	5·36 ,,
E.M.F. at terminals of motor	=	107·33 volts.
Speed of machines ...	=	764 revs. per minute.
Power transmitted by belt ...	=	6604 watts = 8·85 H.P.

"Hence—

Total power given to generator	=	42917 watts = 57·53 H.P.
Power lost in internal friction of armature core	=	831 ,, = 1·11 ,,
Power lost in generator magnets	=	716 ,, = 0·96 ,,
Power lost in generator armature	=	1360 ,, = 1·823 ,,

"And therefore—

Commercial efficiency	=	93·23 per cent.
Loss in core	=	1·94 ,,
,, ,, magnets	=	1·66 ,,
,, ,, armature	=	3·17 ,,

"Similarly for the motor—

Total power given to motor ...	=	38886 watts = 52·13 H.P.
Power lost in internal friction of core	=	831 ,, = 1·11 ,,
Power lost in motor magnets...	=	472 ,, = 0·63 ,,
,, ,, ,, armature	=	1275 ,, = 1·70 ,,

"And therefore—

Commercial efficiency of motor	=	93·37 per cent.
Loss in core	=	2·14 ,,
,, ,, magnets	=	1·22 ,,
,, ,, armature	=	3·27 ,,

"In the above experiments, it is worthy of note that Lord Rayleigh's determination of the ohm and of the volt have been taken, and not the B. A. units, as in most previous experiments. The effect of this is to lower the efficiency between 1 and 2 per cent. in comparison with tests made on other dynamos, and at the same time to increase the accuracy of the results by this amount.

"These figures, showing an efficiency for the generator of 93·23 per cent., and for the motor 93·37 per cent., are very remarkable, and show much superior results to those obtained with any other dynamo. They show that the dynamo, whether used as a motor or as a generator, when constructed with due regard to scientific principles, is one of the most perfect of known converters of energy from one form into another. They also entirely put an end to the long-maintained opinion that a motor should be designed on different lines from a generator, or that a dynamo is less efficient when used as the former than it is when used as the latter. It appears that the efficiency of the double conversion is 87·05 per cent. Hence, neglecting the loss due to the connecting leads, power can be transmitted electrically with a loss of only 12·95 per cent.—a result far surpassing any previously obtained."

ELECTRIC LOCOMOTION.

By A. RECKENZAUN.

XI.

SECONDARY batteries, popularly but unscientifically called accumulators or storage batteries, have been greatly improved within the last two years, and they are gradually gaining in public favour. The literature on the subject of secondary batteries is extremely meagre and what we have is either antiquated or purely theoretical. It is not within the province of these essays to go much beyond the bare statements of what has been done with secondary batteries, as regards their weight capacity and efficiency; a complete treatment of the method of manufacture would of itself fill a respectable volume, apart from historical considerations. Some day, perhaps, the story of the storage battery may be written; it would provide ample material to a journalist, it could be divided into many chapters each containing a fair mixture of pathos and of humour; and it would not be necessary to draw upon the faculty of imagination.

To a casual observer, the storage battery appears as a very simple affair, and it is simple to those experienced in its manufacture; nevertheless, it absorbed years of study and vast sums of money.

Ingenuity and skill would have been of little avail had it not been for the liberal support, the wonderful faith, the almost heroic action of a few high minded British Capitalists. France may be the birth-place of the secondary battery, but it was in England where the lead accumulator reached maturity and attained a commercial value and an industrial importance, which can hardly be overestimated when rightly understood.

There are at this moment only two manufactories in the world from which it can be said that serviceable and efficient storage batteries are obtainable, although others are in a fair way of following the lead of these. We refer to the Electrical Power Storage Company and to Elwell-Parker, Limited, but it is the former company, only, which has produced secondary batteries suitable for the purposes of electric locomotion. The E.P.S. cells, among other applications, are used on tramcars and on electric launches with success, and we will now proceed to analyse one of the type especially designed for tramcar propulsion.

Such a cell consists of a strong lead-lined teak box, containing 23 lead plates. The box is rectangular, and occupies a space of nearly one-third of a cubic foot, measured externally. The plates, as is well known, are made of lead grids, the perforations of which are filled with lead oxides. The peroxide plates, generally called positives, 11 in number, are slightly heavier than the negatives containing spongy lead, and of which there are 12 in a tramcar cell. The peroxide and the spongy lead are produced by the process of "forming," that is, sending currents through the new plates when immersed in diluted sulphuric acid. A number of India rubber plugs pressed into a corresponding number of holes in the negative plates, keep the electrodes an equal distance apart. The plates are provided with lugs, which lugs are connected by means of lead strips. The negatives are joined together at one end of the cell, and the positives at the other end. These connecting strips are of sufficient sectional area to carry a current of 150 ampères with safety when

necessary. The box is provided with a lid which can be hermetically sealed, a hole with stopper serves for the replenishing of acid, which must reach over the top edge of the plates; the said stopper is withdrawn during the process of charging the cell, for the escape of gases, if any.

The weight of a cell is about 40·5 lbs., made up as follows :—

11 positive plates	12·890 lbs.
12 negative plates	11·062 „
Connecting strips	2·423 „
Diluted sulphuric acid... ...	5·125 „
Box and lid	9·000 „
	40·500 lbs.

Expressing the relative weights in percentages, we get for

Lead plates and connectors	65·123 per cent.
Acid, diluted	12·655 „
Receptacle...	22·222 „
	100·000

Of the 26·375 lbs. of plates and connectors, there are 16·375 lbs. of pure lead or "conducting material," and only 10 lbs. of peroxide and spongy lead, which may be termed "active material."

The active material, therefore, forms less than one-fourth (24·7 per cent.) of the total weight of this secondary battery, whilst the conducting grids and terminals, which, though essential, do not, whilst new, materially add to the storage capacity, weigh 40·4 per cent. of the complete cell. In order to decrease the weight of this battery we should have to reduce the amount of metallic lead in the plates, but then we would also reduce the life as well as the strength of the grids, for the lead conductor of the positive electrodes gets also peroxidised in time. This oxidation takes place in an exact ratio to the amount of work that has been done by the cell, the number of watt-hours it has received and returned.

If we reduce the weight of the tramcar cell we naturally save power in propelling the same along with the vehicle, but as the durability is thereby sacrificed it becomes a question as to whether it be cheaper to replace the positive plates frequently or else to provide an excess of energy for this auto-propulsion.

The problem becomes one somewhat similar to that worked out by Sir William Thomson on the subject of conductors for the electric transmission of energy, viz., that the most economical size of a conductor is that in which the interest on the prime cost equals the money value of the energy wasted in heating the same.

With secondary batteries, if we substitute depreciation for interest, the problem of maximum economy is rather more complex, because, whilst we render the plates more durable by providing more material, we also require from them a higher rate of activity since the greater weight demands more power for its own propulsion. But this increase of weight may only represent a very small fraction of the total load of car, passengers and propelling apparatus.

The main points in the consideration of the subject of the propulsion of cars will resolve themselves into three heads : Firstly, the energy expended in the act of carrying the battery with the car ; secondly, the energy lost in the process of charging and discharging or the efficiency of the secondary battery ; and thirdly, the cost of renewing the plates periodically.

At the ordinary coefficient of resistance to traction on tram rails, one pound weight moved at the rate of six miles an hour will involve the expenditure of seven foot pounds of work per minute. Each cell of the type weighing 40·5 lbs. will thus require 283·5 foot pounds per minute for its own transport. If we were to place 60 such cells upon the 5-ton car, which has previously served as an example, the weight will have to be increased from 11,200 lbs. to 13,630 lbs., and the propelling power (exclusive of motor friction) will have to be augmented by 17,010 foot pounds per minute, which in round numbers means an increase of nearly 22 per cent.

We now place this car upon the line, fig. 8 (article VIII.), and run it at the same speed as before when the energy was supplied through conductors.

The average horse-power, which we then found to be 3·99, will now be 4·88 horse-power at the terminals of the motor, or the battery, as there is no appreciable resistance in the conductor between the two. Twelve such cars with accumulators will, therefore, require 58·56 electrical H.P. for their continuous propulsion. The cars *without* accumulators, exclusive of heat waste in conductors, absorbed 48·54 electrical H.P., but including the heating of conductors 64·84 H.P.

The useful capacity of a tramcar cell averages 140 ampère hours at a high rate of discharge when the average E.M.F. is 1·9 volts ; we have thus a store of energy = 140 × 1·9 watt-hours in a cell, and this represents $\frac{266}{736}$ = ·36141 H.P. hour; this gives 21·6846 H.P. per minute, or in terms of the unit of work 715,592 foot pounds.

Comparing the energy per minute with the weights we obtain some very useful numbers—

$\frac{715592}{26·375}$ = 27,523 foot pounds per pound weight of plates and connectors.

$\frac{715592}{40·5}$ = 17,668 foot pounds per pound weight of the whole cell.

$\frac{715592}{10}$ = 71,559 foot pounds per pound weight of active material.

We may also deduce the relations between weight and coulombs, or weights and watts, but these are not so handy for calculations as the foot pound minutes, or horse-power minutes. The capacity of an accumulator increases slowly as the conducting substance becomes peroxidised, or as the plates get older in use.

ON TELEMICROPHONIC APPARATUS.

By M. E. MERCADIER.

I GIVE the name telemicrophonic to mixed apparatus which produce simultaneously the effects of microphones and telephones and which are reversible like the latter. Their construction, as regards transmission, rests on the following facts :

1. We may act upon a telephone or a microphone by the intervention of any thin *rigid* plate whatever and of a stratum of air, limited or not.

2. We may, without causing a magnetic diaphragm to lose its telephonic properties, load it with weight up to a certain limit, which may even exceed the weight of the diaphragm. These two properties were indicated in the theory of the telephone which I gave in the *Comptes Rendus* (vol. CI., pp. 744 and 1001).

3. The effects of a microphone placed in the primary circuit of an induction coil and of a telephone placed in the secondary circuit are superimposed when we act simultaneously upon both apparatus, either superimposing themselves or placing them in juxtaposition, or combining them intimately, the microphone being fixed to the membrane of the telephone.

As regards reception we may base it upon the following principle which I have indicated as regards radiophonic effects (*Comptes Rendus*, vol. CI., p. 944), a principle already applied, but incompletely.

4. When the membrane of any telephone whatever separates two air-chambers, the one without and the other within the instrument, we may receive distinctly and strongly the movements of the membrane transmitted to the air by the aid of one or more acoustic

tubes adapted laterally to these chambers, provided we give them suitable dimensions.

In accordance with these data I have had constructed two types of telemicrophones which give good results, the one in which the telephonic and microphonic organs are superimposed and the other in which they are combined.

We easily obtain an apparatus of this latter type by the aid of a D'Arsonval telephone, to the membrane of which are firmly fixed the carbons surrounded by a thin iron cylinder of a microphone of the system of D'Arsonval and P. Bert. These carbons are in the interior of the apparatus, a small auxiliary magnet regulating their pressure upon their support.

The membrane is surmounted by a lid forming an air chamber of at most 0·01 metre in height, perforated with a central aperture covered with any thin rigid plate (glass, mica, wood, &c.) against which we speak, and by two lateral apertures to which caoutchouc tubes may be adjusted.

The electric communications are the same as in an ordinary microphone; the carbons are connected to the primary circuit of an induction circuit comprising the battery; the extremities of the coil of the telephone are connected to the outer circuit comprising the secondary wire of the bobbin.

As regards transmission, when we speak into the apparatus the iron membrane vibrates and produces simultaneously the following two main effects: 1, a microphonic effect in the primary circuit of the bobbin, consequently movements of the carbons fixed to the membrane whence result ordinary induced currents in the outer circuit; 2, a telephonic effect in consequence of the movements of the membrane in the field of the magnet whence result in the same outer circuit other induced currents which are superimposed on the former.

Although the weight of the carbons is greater than that of the diaphragm and is irregularly distributed over its surface, the apparatus acts very well as a telephone if we suppress the microphonic effect, *e.g.*, by opening the circuit of the battery; if, therefore, this suppression is produced accidentally the transmission may continue without difficulty.

As for the reception, the apparatus is reversible, since it contains all the elements of a telephone. To use it as a recipient it is sufficient to raise it to the ear. If we wish to leave it on a fixed support we make use of acoustic tubes adapted either to the lid or to the chamber formed in the interior of the instrument. Care must be taken, as mentioned above, to have suitable dimensions so as to avoid the effects of resonance, which give a sort of blur to articulate speech.

In determining these dimensions we may, without notably reducing the effects, adapt several acoustic tubes of small diameter (about 0·01 metre in diameter) to each of the air chambers of the apparatus. This enables several persons to receive at once the sounds on the words transmitted. We obtain thus a telemicrophone with multiple hearing tubes.

It will be seen, moreover, that this arrangement is applicable to ordinary telephones. I have thus, in fact, constructed telephones with 2, 4 and even 8 lateral hearing tubes, giving results capable of interesting applications.

The chief advantages of telemicrophones over ordinary microphones are the possibility of a double mode of transmission with the same apparatus, the reversibility of the transmitter which much simplifies reception; the reduction of the number of organs of microphonic stations and consequently the decrease of the total resistance of the apparatus on one and the same line. This reduction permits us to simplify the construction of the apparatus and to diminish considerably their volume.

Electrical Cons.—Why is a bad workman like a secondary battery?—Because he is so frequently discharged! When is a good workman like a bad secondary battery?—When he buckles to!

THE AMERICAN NATIONAL ELECTRIC LIGHT ASSOCIATION.

THE annual meetings of the National Electric Light Association of America were held at Baltimore, Md., on the 10th, 11th and 12th ult.

The President of the Association, Mr. Frank J. Morrison, on the 10th, took the chair, and introduced the Hon. James Hodges, the Mayor of Baltimore, who delivered an address of welcome to the Association. The following papers, amongst others, were read during the meetings:—

THE PROPER CONSTRUCTION AND MAINTENANCE OF CIRCUITS.

By Mr. E. R. WEEKS.

As the subjects of underground conduit and incandescent lighting were assigned to other committees, the following notes will apply to aërial arc circuits only.

Under the head of construction may be considered line wire, supports, lamps and station connections; under that of maintenance, lines, lamps and dynamos. Since the important subject of line wire was given to another committee, its discussion is omitted.

To guard against "trouble" and to facilitate its removal, the line should, as far as possible, be in sight from the ground, and should be so placed as to be readily reached. By such construction, trouble and the cost of attendance are reduced to a minimum, and one is freed from the endless complications of housetop work, with its manifold objections, *i.e.*, rights to be begged, bought or stolen; continuous delays in removing "trouble;" costly repairs to roofs, chimneys and fire-walls; together with all the thrilling adventures of a lineman.

On some narrow and overcrowded streets it may be policy to erect iron standards; but the danger of fire and of ground shocks is so great with such supports, that those of wood are much to be preferred.

To prevent the insulations being cut by tie wires and to guard against excessive slack from stretching, poles should not be more than 100 feet apart. With the best material and good workmanship, and by paying more attention to the general appearance of the line, we may gain in efficiency and do much toward silencing the outcry against overhead wires.

Aside from the necessity to comply therewith, the rules of the Board of Underwriters should be observed, because they are founded on reason and are *generally* conducive to the interests of all parties. There *must* be a positive "cut-out" on every loop. But, instead of placing it upon the building containing the lamps to be cut off, it has been found better to provide for it a special pole or support, as near as possible, of course, to the entrance to the building, but independent of it or of any structure which is likely to be destroyed by fire. By so doing, control of the circuit is retained in the event of the total destruction of the building containing the loop. There have been instances where such an arrangement would have saved the circuit and prevented loss from rebate. Where high tension currents are employed, porcelain should not be used for outside insulation. The best insulators for this service are of hard rubber and of glass. By means of wall blocks and brackets, rubber hooks and glass insulators may be used for all outside work where it is common to employ porcelain knobs.

In entering buildings additional insulation of hard rubber tubing should be used. To avoid damage from water, have entrance holes bored upward from the outside, and let the wire run from a fixture placed below the exterior opening, so that all drip shall be away from the building. For like drainage purposes, glass insulators are to be set at an upward angle and rubber hooks pointed downward.

Lamps must be suspended by some perfect insulator; vulcanised rings being the best known to our experience. The best service is given by stationary lamps. This is especially true of outside lights. Those hung with raising and lowering tackle are more liable to wear, breakage and variable contacts than are rigid lamps; and in cold weather the tackle may become so clogged with ice as to render them inaccessible. For like reasons, when it is necessary to place the light toward the middle of the street, some device similar to the Brady mast arm will prove most satisfactory.

Hoods should be sufficiently large not only to protect the lamp from the weather, but to allow access to its works while it is in service. The conical form, since it offers least resistance to the wind, is preferable to other shapes.

Globes should be deep enough to cover the arc when the lamp is trimmed full, and the aperture at the top should be no wider than will just allow the rod and holder to pass freely.

The dynamo room should be a clean, dry, well-ventilated apartment. In no other can electrical machinery be kept in a condition to do the best and most reliable work. Let every dynamo be set on some sort of frame by means of which the tension of the belt can be easily changed, and in addition, let it be carefully insulated from this frame by blocks of paraffined wood or some other equally good insulation. Wires from the machine to the switch-board are best run either by way of the ceiling or beneath the flooring. Under no circumstances should they be laid upon the floor, where they are not only in the way, but are sure to lose their insulation through dirt and wear.

All station wires should be cased in rubber tubing as high as a

man's head, and cables and lines connected with the switch-boards must have similar coverings to guard against short circuits, fire and injury to employés. To protect both machines and lamps, and the property of patrons, every circuit ought to have lightning arresters at the station, one on each wire.

The proper maintenance of lines requires that all other wires be excluded from electric light poles. The apparent economy of partnership poles is more than offset by the increased care required to maintain lines in good condition. Such a combined system will result in greater danger of crosses and grounds, fires will be more frequent, and the lives of men unacquainted with the handling of electric light wires will be jeopardised.

The insulation of circuits should be tested several times daily, and all lines patrolled frequently. In searching for grounds, and in repairing open circuits, much time may be saved by using a magneto. Having attached the two wires of the open circuit to the station bell box, the lineman, with a duplicate magneto, goes to the break. When the wires are ready for connection, he uses the magneto to signal the station that the current may be turned on in five minutes, or some other previously determined period. In this way a search for a telephone or a walk to the station will be avoided and rebates will be reduced.

Dirt must not be allowed to accumulate on any part of the lamp. Rods, bases, switches, contacts, bushings and globes should be kept clean, and screws well set. Rods require frequent burnishings with crocus cloth. Let there be a system of rigid inspection at varying intervals, and full and exact reports from the inspector as to the work of each lampman.

If properly tended, lamps need very little adjusting. In nine cases out of ten, adjusting simply means cleaning. But one man should attend to the adjustment of any set of lamps, and these, if properly cared for by the lampman, ought to run for a long period, with little other attention. As often as once in two years at least it is well for the lamps to be returned to the station to receive a thorough overhauling, and to be repainted that they may present as creditable an appearance as possible.

In the annual contract with the consumer there should be a clause especially stating that any working with the lamp by other than electric light employés will relieve the lighting company from all responsibility for failure of light. Employés should be provided with badges worn in plain sight.

Machines run in series do not give as good results as when run singly. The tension is increased to the danger point, while oscillation and all other kinds of trouble are more difficult to overcome.

The insulation of dynamos must be tested as often as is that of the outside circuit, and all circuit connections and binding foot screws must be kept tight.

Having given the machine the most favourable setting, it still needs intelligent attention to maintain it in an efficient condition. Except in an unusual emergency the necessity for calling an expert will generally mean that the machine has not had proper care. The insulating parts will probably be found greasy and gummy and coated with metallic dust, which destroys insulation and causes trouble of various kinds.

In conclusion, it may be said that if circuits are properly constructed and cared for, they should work satisfactorily. If they do not do so, if they are in constant need of repairs, if lamps require frequent adjustments, if bushings are continually burning out, the *meaning* is careless attendance; and of all this carelessness, failure in cleanliness will be found the most common fault. Given a well constructed circuit, cleanliness is the ounce of prevention that will obviate 90 per cent. of the vexations of electric lighting.

Mr. COOPER remarked that in Brooklyn they found that the poles were near enough to each other when 250 feet apart; certainly 150 feet, instead of 100, was quite close enough.

Mr. KING explained the operation of the system in use by his company in Minneapolis for suspending arc lamps at street intersections, running the lamps out by means of a sheave, pulley and winding drum. It was found a cheap, effective and popular system. The cost was $6\frac{1}{2}$ for the apparatus.

Mr. COOPER and Mr. LINNELL both said they had met with practical opposition and objection to running lamps out across the streets.

Mr. RIDLON: The greatest objection to the stringing of lamps in this way is the liability to accident from the fall of a lamp, which weighs from 50 to 65 lbs. I have known cases where running the lamp to and fro has worn the suspending wire away so that the lamp fell, with great danger to people and carriages passing. It is strongly objected to in New England, and in Worcester they have had one or two accidents of that kind, bringing down not only the lamp but the circuit; and they have gone to considerable expense and built a sort of tramway for the lamp to run out on, capable of supporting at least two or three hundred pounds.

Mr. WEEKS contended that as the pole system involved cheaper construction and cheaper maintenance the other plans must fall to the ground. Where tackle was hitched to a house it had to be moved should the house be pulled down. He knew of a case where a man had a 75-foot derrick, and had it moving up and down until he brought the electric light people to terms. Another great and insuperable trouble with these movable lamps was the variable contacts.

Mr. SMITH, of Jamestown, N. Y., said they used a rope in connection with their lights; but it was pointed out that in practice it was found that evil disposed persons could meddle with the rope.

ELECTRICAL TRANSMISSION OF POWER.

By CHAS. J. VAN DEPOELE.

During the summer months of 1885 I entered into a contract with the directors of the Toronto, Ont., annual exhibition, to run a train of three cars and a motor car from the street railway terminus to the upper grounds of the exposition, a distance of a mile. Having only a single track, I had to prepare here for a light train and good speed. The plant consisted of the following:—One steam engine, 10 by 16, running 125 revolutions per minute, driving an ordinary 40-light (arc) machine, having an E.M.F. of about 1,400 volts and an intensity of current of about 18 ampères. The engine and dynamo were placed in Machinery Hall, close to the boiler room.

The dynamo was connected, one pole with the rails, which were fastened together by means of fish plates, and the other pole to an overhead wire, hanging over the centre of the track, by means of arms extending from poles placed along the length of the track. On top of the car, on which the motor was placed, was a contact wheel carried by a pivoted beam, the latter being provided with a spring on one end pressing the wheel at the other end up against the underside of the overhead wire. This contact wheel was in communication, by means of a flexible cable, with the switches, rheostat and motor; from the motor the current was carried to the axles of the wheels, the wheels to the track, thus closing the circuit upon the generator.

We began placing poles, &c., on September 1st, and made our first trip on September 5th. From beginning till end not the slightest hitch occurred, running regularly from 8 a.m. till 10.30 p.m. without stopping a minute. On many occasions we carried from 225 to 250 people. On one end of the track we had a 200 feet curve to start, then a level of some 2,000 feet, with two curves of about 1,000 feet radius, then a grade of some 1,500 feet, gaining gradually to about 6 per cent. The rest of the road had a downward grade to the terminus, which made it a disadvantage in starting. As above said, the distance was a mile, and the round trip never exceeded eight minutes, so that including starting and stopping, we made for part of the way at least 30 miles per hour. During the last five days of the fair we carried 50,000 people. The consumption of coal, as given by Doty and Sons, who ran the engine, was on an average of 1,000 lbs. in 10 hours.

The next step was to South Bend, Ind., where we equipped four ordinary street cars, one large open car with a 10 H.P. motor, and the other three closed cars, each with a 5 H.P. motor. The large car was run for the first time on November 14th, 1885, and was packed with humanity to its utmost capacity. Everything worked like a charm. The plant consists at present of the following:—A 50 H.P. water wheel, and two 20 H.P. generators, and, as above stated, one 10, and three 5 H.P. motors. The track is laid with the ordinary flat rail, so in order to connect the rails together we placed copper plates 3 inches by 12 inches under the joints and spiked the rails down on both sides of the track, so that there is no chance of breaking circuit. As will be understood, the rails in the present case form again one part of the circuit, the other part consists of a copper wire $\frac{1}{4}$ inch diameter suspended above the track, from cross wires fastened to poles placed near the curbstone, and at a distance of about 100 feet apart. From the under side of this copper wire or conductor hangs a carriage, fastened to a flexible cable, passing to the inside of the car, where it is in connection with the switches, the motor, &c.; this carriage travels along with the car, and makes a perfect contact. After the first trial of November 14th the 5 H.P. motors were soon in place and have worked admirably. The tracks are never perfectly clean, on account of constant traffic over the road, but since both rails are connected and also all four of the wheels, it is almost impossible to break circuit between the motor and the rails. The cars have run right along through mud and snow, and no trouble has been experienced with the circuit.

On running the four cars at once, the generators work perfectly, from 6 in the morning until 11 p.m., requiring not the slightest attention; the brushes are set in the morning, and are not touched afterwards. Every car works independently, back or forward, without interfering with the others; the division of the current leaves nothing to be desired. The only trouble we have encountered with the plant has been with some small mechanical details, such as link bolts breaking, &c. These, of course, being small matters, are easily remedied. The main point here was the electrical part, and this has proved to be an unqualified success.

The length of the present road is about $2\frac{1}{2}$ miles. The other roads will be equipped as soon as the weather allows of the placing of the poles for the cross wires.

On the 6th day of October, 1885, we entered into a contract with Mr. McConnico, President of the New Orleans Exposition, to run a train of cars in the grounds, with a carrying capacity of from 180 to 200 people. This road is similar to the one in Toronto, nearly a mile long, running from St. Charles Street main entrance, along the Government buildings through the grounds, to the main building and Art Hall.

All was ready for operation for the opening day, but on account of delay in obtaining steam power, we only began running regularly on the 14th of December.

The heaviest work we have done, so far, is in Minneapolis, Minn., and that during the winter months when snow and ice are faithful companions on the track; whether invited or not, they are there, and never fail.

Before undertaking the job, I was very much afraid that electricity would not be practicable in a climate where the thermo-

meter rises seldom above the freezing point for at least three months of the year. All my fears, however, have been removed in the past six weeks; we have ascended the grades and turned the curves with at least as much facility as the steam dummies.

The electrical plant consists at present of one 60 H.P. generator and a 50 H.P. motor. Our circuit consists of the rails for one side and an overhead copper wire $\frac{3}{10}$ inch in diameter for the other side.

In South Bend we have water power as the prime motor. We ran for the first time on New Year's Eve, 1885, and continued on New Year's Day. The water wheel had no governor, and we found it rather dangerous for the generator. As the water wheel had to be governed by hand, it was impossible to keep the speed anywhere near constant. It was decided to put a governor on before running regularly. Several trips, however, were made over the entire length of the road, giving entire satisfaction. The weight of motor is 3,500 lbs., and the total weight of motor car or electric locomotive is 8 tons. The passenger cars in use here are similar to those on the New York Elevated. In some instances we had three to four inches of solid ice on the track and broke our way through it without the least trouble; in a few days the water power will be in shape to run regularly, when we will run on schedule time.

Thus far we have demonstrated that electric railroads can be operated anywhere where the steam motor can go, and that there is much in favour of the electric motor in cold countries is very evident; there is no danger of pumps freezing up, nor of brakes becoming inoperative; no water tanks are needed along the road, nor is there any coal to be taken; in fact, there are thousands of advantages in the application of the electric locomotive on street and other railroads. Whenever water power is obtainable the economy need not be disputed, and even in the case where steam is to be used as a prime motor there will be considerable economy.

No cheaper or better plant can be expected to run light trains on suburban roads than the electric motor; as, for instance, in the Detroit road now in progress, connecting the latter city with Dearborn, a single train will be run with six large-sized street cars; the speed will be from 15 to 20 miles an hour, the length of this road is nearly three miles, and it will be in operation in a few weeks.

A similar road will be in operation early in the spring in Appleton, Wis. In this case, however, six cars will be equipped with 10 horse-power motors and run independently; the length of road is about eight miles; the speed about ten miles per hour. Water power will be used to run the generators.

The street railway in Montgomery, Ala., is now being equipped with our motors, twelve cars in all, and will be running within thirty days.

In all the above places we are using overhead conductors, which are no more of an obstruction than the ordinary telegraph and electric light wires; in fact much less, since the conductors are over the centre of the roads, so that wherever wires are allowed for other purposes, they cannot be refused for the present purposes. I do not believe, however, that overhead wires would be practical in large cities where other wires have to be buried; but in this case the electric conductors can be placed underground in conduits similar to those used for cable cars. This will be much more expensive than the overhead conductors, but it will be a permanent and practical fixture.

I feel sorry that I have not found more time to prepare some figures with regard to tests of motors and general transmission, but the above is a *résume* from practical experience and facts on the track instead of on paper. I am a solid believer in the saying that experience is the best teacher, and to all the above I have attended personally from beginning to end, and am more than ever convinced that the electrical transmission of power has not only ceased to be ephemeral, but has become a real fact and a blessing to the world. All is ready, it has only to be applied judiciously and success is imminent. Thousands of horse-power are now running waste in our waterfalls which can all be utilised to advantage, in some cases running our tramways, in others our factories, &c., giving at the same time light and cheer during the absence of old Sol.

LIGHTING FROM PRIMARY BATTERIES.

By ALLAN V. GARRATT.

I need not tell you, gentlemen, that I have not come here to warn you against forming crude and hastily adopted notions in regard to the electrical system which I represent, for I believe that the electric light companies of this country are represented by men who do not jump hastily at conclusions, and who are not in the habit of taking things for granted; but I ask you in all fairness not to unthinkingly class our system of lighting with those inventions which periodically appear before the public with meteor-like brilliancy, claiming to do that which every scientist knows to be impossible with the materials at their disposal; companies whose exodus from the business arena is as sudden and to the uninitiated as unexpected as their advent, and in regard to whose end we must remain silent if we wish to be charitable.

Had it not been for the scholarly paper (by Dr. Moses) to which we had the pleasure of listening yesterday morning, I had intended to speak in detail of those early experiments with the voltaic current; experiments beginning with Professor Volta, of Pavia, in the year 1800, when he constructed his electric pile, followed by his *couronne de tasses*, or crown of cups, which suggested to Sir Humphrey Davy his brilliant experiment of the same year, when he dazzled the whole world by producing for the first time the electric arc. These experiments were followed by others so numerous that were I even to enumerate them, I am sure I should be imposing upon your patience. It is sufficient to say that in the years which followed, a few scientists, conspicuous among whom were Daniell, Grove, Smee, Bunsen, and Poggendorf, won for themselves renown which is historic.

I need not remind you that there are especial points of activity and stagnation in the history of all science, and that at about the middle of the present century electricians had well-nigh abandoned the hope of producing powerful and continuous currents of electricity by primary batteries, and the attention of electrical investigators was turned more especially to the theory of electro-magnetic induction, as advanced by Faraday as early as 1831, after which followed many inventions, conspicuous among which were those of Pixii, Pacinotti, Siemens, Wheatstone, and Gramme; and in this way the whole question of producing powerful currents of electricity by purely chemical means fell into the background and became looked upon as a thing of the past, and the problem of converting the heat which accompanies the rapid oxidation of fuel into motion, and from motion into electricity, became the absorbing question of the day.

The latter half of the present decade has, however, marked an epoch of remarkable activity and interest in the subject of producing powerful electric currents by primary batteries, and electricians are now working actively on this question.

In the present state of the art it is not becoming in any man to stand upon the floor of this convention and claim to do with a primary battery that which can be done with a good dynamo machine; but, as you know right well, the question is not always, how much electric light can you produce within economic figures, but you are oftentimes asked, how little light can you furnish from an isolated plant at a price which consumers will pay?

This is precisely the question which I am prepared to answer. A primary battery capable of successfully lighting for a number of hundred hours a single incandescent lamp, or, if necessary, a score of them, is not an invention to be put aside as wholly insignificant.

I speak conservatively when I say that it makes not only possible, but feasible, the electric lighting of a single house, a yacht, a parlour or sleeping car, or even a man's own private carriage. It also places at the disposal of every physician and surgeon a light always ready and requiring but little care, with which he can explore the interior of the human body. I need not suggest other uses for such a light; they suggest themselves to every one. This is a field of electric lighting which is out of the reach of the dynamo machine.

The Chemical Electric Light and Power Company, of Boston, of which I am the representative, is to day putting out plants for the purposes which I have enumerated. It controls by letters patent the use in a voltaic battery of those chemicals which alone make possible practical results.

Heretofore a battery which could maintain an electric light for twenty hours was looked upon as phenomenal. The Chemical Electric Light and Power Company have placed a plant in the New York Mutual Life Insurance Building of Boston, which gives the elevator car 300 hours of good light with one charge of battery solution. We are furnishing light at prices which we find the consumers are willing to pay.

I have intentionally refrained from going into the details of construction of our battery, or the composition of our solutions. I should not feel justified in occupying the floor of this convention for any such purpose. I wish simply to say that we have no secrets, and the structure of our battery and the chemicals which we use are at all times open to inspection. The time has gone by for any one to claim to produce electricity or electric light for the public in any way which does not appeal to the good judgment and common sense of practical men who are skilled in this particular branch of applied science.

I will not longer take your time with this matter.

In closing, I wish to say that it has been to me a pleasure to bring before the National Electric Light Association the first practical device for producing the electric light in commercial quantities and within economic figures, by purely chemical means, without the intervention of any mechanical force whatever.

LOCAL AUTHORITIES AND OVERHEAD WIRES.

ON Friday, last week, a special meeting of the Torquay Local Board was held to consider, amongst other matters, the petition which has been filed by the Western Counties and South Wales Telephone Company in opposition to the Torquay Harbour Purchase Bill, and to determine thereon.

The CLERK stated that Clause 130 of the Bill proposes to empower the Local Board to make, alter and repeal bye-laws, for the prevention of danger or obstruction to the public from posts, wires, tubes, or any other appliances or apparatus stretched or placed over, across, under, or in any street, for the purpose of any telegraph, telephone, railway signalling or other purpose; and by such bye-laws to provide for the inspection and examination of any such posts, &c. In its petition the Telephone Company set forth that it had opened a telephone exchange at Torquay; that it was

encouraged by the Improvement Committee to enter upon the undertaking, and, accordingly, has caused posts to be erected and wires to be stretched, or placed over or across certain streets within the district. It admits the propriety of the Board having the power to make examinations of posts, wires, and tubes; but holds that the Board ought not to be empowered to make bye-laws for the prohibition of the same. The Company further contends that, although it is proposed that nothing in the bye-laws shall extend to any existing works until the expiration of five years from the passing of the Act, such a provision would be perfectly futile, inasmuch as the present works cannot be made immediately remunerative, and can only become so by an extension of the system. This would involve the erection of poles and other apparatus, and the stretching of additional wires across streets included in the district. On these grounds the Company objects to the extension of the provisions of the Bill to their existing works, and submits that they would be unjust and arbitrary. A letter was read from Messrs. Batten, Proffit, and Scott, Parliamentary agents for the Bill, stating that on behalf of the Lancashire and Cheshire Telephone Company they opposed the Liverpool Bill, which contained similar provisions to the Torquay Bill; and that after considerable discussion the clauses in the Liverpool Bill were settled and accepted, not only by the provincial telephone companies, but also by the chief company in London, as the precedent of clauses in similar Bills giving control over wires belonging to private companies to local authorities. This precedent had since been followed, and they consequently advised the Board to stand by the clauses. In another letter Messrs. Batten stated that they had served a notice objecting to the *locus standi* of the Telephone Company, and that they had privately heard that the opposition was supported by the chief London Company, which was desirous of getting the clauses already granted in favour of local authorities modified as regarded the absolute prohibition of telephone wires in their districts.

Mr. BRIDGES moved that the action of the Telephone Company in opposing the Bill should be opposed by the Local Board, and that the necessary steps should be taken for that purpose.

The resolution having been carried without dissent, a small committee was appointed to watch the progress of the Bill.

NOTES.

The National Electric Light Association at Baltimore. — This meeting, which took place at the beginning of last month, was a marked success, and some of the papers will be of interest to our readers. The three matters which appeared of most pressing interest to the members, were the distribution of power electrically, the use of incandescent lamps on arc circuits, and the use of primary batteries for lighting; while the evidences were numerous throughout that the whole business of electric lighting in America has reached a period when it may be said to rest upon a solid and lasting foundation of pecuniary success. The gathering of electrical men was the largest since the Philadelphia Conference of 1884.

The Electric Light in Modern Warfare.—The fact that nearly every commissioned vessel in the Royal Navy of any importance is fitted with the electric light may be regarded as ample proof of the importance which is attached to its use in modern naval warfare by the Admiralty, as well as by many experienced officers. To the long category of the last-mentioned may be added the name of Admiral Freemantle, who, in a recent paper referring to naval warfare read at the United Service Institution, expressed himself in favour of the use of the electric light, as it prevented the officer of a torpedo boat from accurately judging distances, and, in fact, from seeing what he was about.

The Electric Light on a Steamship.—Following the wise example of the P. and O. and other large steamship companies, the Royal West India Mail Packet Company is having its steamship *Trent* fitted with the electric light at Southampton. The work is being carried out by Messrs. Siemens. It is probable that the West India Company will, provided that the present installation is satisfactory, introduce the electric light on all the steamships under its direction. By doing so it would, without a doubt, greatly conduce to the comfort of the passengers during long voyages.

The Electric Lighting Act.—Lord Rayleigh, in the House of Lords on Tuesday, introduced a Bill to amend the Electric Lighting Act of 1882, which was read a first time.

In the House of Commons on the same day, in reply to Mr. Northcote, Mr. Mundella, President of the Board of Trade, said: I am not prepared at this moment to state exactly what course will be taken with the one Bill and two provisional orders which this session seek authority, among other things, to amend the Electric Lighting Act, 1882. I may say, however, that the Government could not permit any amendment of the general law to be effected by means of a private Bill or a provisional order. The whole question is under the consideration of the Government, and will, if possible, be dealt with during the present session.

Lighting of the House of Lords.—The lighting and ventilation of the House of Lords was under discussion on Tuesday, when the Earl of Milltown remarked that it would materially add to the comfort of the House if the blaze of gas which poured down upon their lordships' heads in an evening could be got rid of.

Cost of Gas in Portugal.—A company for the supply of gas in Portugal, where the charges for that description of light are far above those ruling in other European States, and where the existing works are inadequate to the wants of the community, will shortly be brought out. The cost of production in Portugal is said to be less than 3s. 6d. per 1,000 feet, while the selling price ranges from 6s. to 8s. 6d. per 1,000. We wonder that no enterprising firm has availed itself of the excellent opening which here exists for an extensive introduction of electric lighting.

Electric Lighting of the Bar Library.—In the House of Commons this week, in answer to Mr. A. O'Connor, Mr. Leveson Gower said it was intended in the coming estimates to ask for a sum of £400 for the electric lighting of the Bar Library in the Law Courts, and as soon as the money was granted the work would at once be taken in hand.

An Electric Lighting Scheme Abandoned.—At the last meeting of the St. Saviour's Board of Guardians a report was received from the Building Committee stating that, after carefully considering the tabulated statement of tenders that had been received for lighting the infirmary at Champion Hill with the electric light, and conferring with Mr. Jarvis, the architect, on the probable cost of lighting that establishment with gas, the committee recommended that the tenders for electric lighting be no further considered, and that specifications and drawings for lighting the new infirmary with gas be prepared. The chairman said the majority of the committee were of opinion that they should have gas to begin with. If, in the course of a few years, the electric light was perfected it might be introduced, with perhaps good effect. Mr. Cooksey maintained that the electric light was an unqualified success, and urged its use on sanitary grounds. After some discussion the report was adopted.

Electric Lighting at Dalton.—At the last monthly meeting of the Dalton Local Board the clerk reported, on behalf of the Electric Lighting Committee, that numerous letters from engineers, and also from firms in relation to the supply of plant for electric lighting purposes had been read. A letter from the Board of Trade had also been read, stating that it would be necessary before depositing patterns that the Local Board should state the system of lighting proposed to be adopted:—(*a*) for incandescent lighting; (*b*) for arc lighting; specifying full details as to efficiency in, and safety of supply. The Local Government Board had written, stating that a local inquiry would be held upon the Board's application for sanction to loan. The report was, after a long discussion, adopted.

Electric Lighting and Shipbuilding.—Palmer's Shipbuilding Company, at Jarrow-on-Tyne, intends, according to *Gas and Water*, to finish the Government belted cruisers with the assistance of the electric light. The wires are exceptionally thick, and are being laid in the most obscure parts of the vessels. The intricate nature of the work to be performed, now that the ships are well advanced, renders the most perfect lighting arrangements necessary.

The New Telephone.—In an article on "The Telephone Monopoly," the *Contractor* says that at last there seems to be some reasonable hope that the gigantic monopoly held by the United Telephone Company will have to permit the escape of one or two instruments from its clutches. Further on the article states that Prof. Silvanus Thompson, who began his researches with the avowed object of showing that Bell had not exhausted all the methods by which articulate speech can be transmitted, has perfected the "Valve" transmitter; and the United Company has in consequence come to the conclusion that the success which has invariably attended its efforts in the past, in the direction of crushing competition, might on this occasion be conspicuous by its absence. Some reference to the Valve transmitter, not altogether of a favourable character, will be found in our Correspondence columns.

The Telephone on Steamers.—Mr. Hulton, manager of the Northern District Telephone Company, writes: "I notice in your impression of February 26th, a paragraph stating that the telephone has been utilised on a steamer for the first time at New Bedford, Mass. Now the cousins across the water are without a doubt smart, and generally up to the times, but they are not always first, and we may as well take credit for it when we are first on this side of the herring pond. As far back as 1883 telephones were fitted on a steamer at Newcastle, by Mr. R. Hope Jones, on behalf of the United Telephone Company."

Music by Telephone.—The music and songs of the "Mikado" laid on from the Theatre Royal, Newcastle, are a source of continual enjoyment to the Sunderland subscribers of the Northern District Telephone Company, and during the present "snowed up" state of the inhabitants, the telephone, according to information received, becomes about the only available means of communication with the outer world.

Telephonic Communication in Case of Fire.—The Plymouth Town Council has adopted a recommendation of the Watch Committee, which, with the view of rendering more efficient the Fire Brigade service of the Borough, reported that it was desirable that arrangements should be made for establishing telephonic communication between the central and branch police station and the residence of the Borough Surveyor. It had been ascertained that the Western Counties and South Wales Telephone Company was prepared to lay the wires and provide the necessary instruments for an annual rental of £33, and the Council directed a contract to that effect to be made with the company.

Telephone Exchange for Bournemouth.—The preliminary steps in connection with the establishment of a telephone exchange at Bournemouth are now in a forward condition, and a derrick has been erected on premises at the corner of Albert Road. A number of prominent tradesmen have consented to become members of the exchange, which will connect Bournemouth with the adjacent town of Poole. The yearly subscription is based on the lowest tariff in England, which, it is believed, will be the means of inducing many private residents to become subscribers.

The Postmaster-General of South Australia.—The following brief record of the public services, &c., of Mr. Charles Todd, C.M.G., Postmaster-General and Superintendent of Telegraphs of South Australia, who read a paper on "Telegraphic Enterprise in Australasia," before the Royal Colonial Institute, recently, is taken from the Colonial Office List:—"Member Royal Meteorological Society; Fellow of Astronomical Society; Assistant-Astronomer, Cambridge, 1848; Assistant-Astronomer Royal Observatory, Greenwich, 1854; Observer and Superintendent of Telegraphs South Australia, 1855; Postmaster-General and Government Astronomer, 1871; C.M.G., 1872." Mr. Todd's name will always be inseparably associated with the establishment of direct communication with the Australian Colonies in 1872. The construction of a land line across the Continent from south to north was persistently advocated by him even before the time of Mr. J. McDouall Stuart's memorable exploration, and this great work was successfully accomplished at the expense of the South Australian Government, under the immediate supervision of Mr. Todd.

Telegraphic Facilities at Portsmouth.—In connection with the new and spacious central postal telegraph office at Portsmouth, an improvement has been effected which will, no doubt, be highly appreciated by the public. Hitherto, telegraphic messages have been handed in at the ordinary office where the postal work is transacted, and received by clerks unconnected with the telegraph department. Consequently the senders of telegrams have had to wait their turn at the counter, and as time is oftentimes most valuable under such circumstances, considerable inconvenience has frequently resulted. In order to obviate this inconvenience, a special office has been built for the transaction of the work devolving on the telegraph department. Trained telegraphists are on duty to receive the messages, and transmit them as soon as they are handed in; and by this means, while the Post Office clerks are relieved of duties which are not included in their legitimate functions, a great advantage is also gained by the public, and increased efficiency secured all round.

Telegrams to the Royal Courts of Justice.—The superintendent has issued the following notice respecting the transmission of telegrams to the Royal Courts of Justice:—Telegrams will be wired direct to the office, No. 605, in the Royal Courts of Justice, and will be delivered therefrom by a messenger into the rooms indicated. The surname, number of room, and "Courts Justice" will be the recognised address for all town messages, "London" being added if sent from a country district. No title, initials, or Christian name will be necessary, except only the latter where two officers of the same name occupy one room.

Suicide of an Australian Telegraph Official.—The *Colonies and India* states that Mr. J. Farnell, telegraph construction overseer at Tamworth, New South Wales, and son of Mr. J. S. Farnell, late Minister for Lands, has committed suicide. No cause is assigned for the act, as the deceased had been cheerful and chatty to his friends just before.

Induction in Submarine Cables.—The *Engineer* of last week says:—"We think Prof. Hughes's discoveries should induce cable companies to perceive that the time-honoured system of surrounding the conductor of a submarine cable by a protecting sheathing of twisted iron wires is electrically the very worst possible arrangement. Iron, by its magnetic properties, increases enormously the self-induction of the copper core, and therefore decreases the speed of signalling. When the first cables were laid there was some excuse for employing iron and steel for the purpose of protecting submarine cables, because no other non-magnetic metal was known which had sufficient tensile strength. But now-a-days, when there is a large number of bronzes obtainable, most of them nearly equal, and some quite equal to best steel in tensile strength, there is no reason why the practice of surrounding cables with a magnetic envelope should be continued. Another valuable lesson to be learned from

the experiments above-mentioned refers to lightning conductors. If a solid wire offers by its self-induction twenty times as much resistance to the incipient current as a stranded cable of equal cross sectional area, then the facility to conduct quickly to earth a lightning discharge is in the latter case so much greater than in the former, that solid rods should never be used. It is a curious fact that popular opinion has for years been in favour of flat strips instead of solid rods for lightning conductors. In the absence of any scientific reason for such an opinion, we would certainly have considered this a case of popular superstition, like many others; but now Prof. Hughes's experiments have shown that there is actually good scientific reason for an opinion which, far from being merely a superstition, was rather a manifestation of the popular scientific instinct backed by experience."

Submarine Cables and Imperial Interests.—Mr. J. H. Heaton gave notice on the 19th ult. that on going into Committee of Supply on Friday, March 20, he would move the following resolutions:—(1) That it is desirable to place the whole Naval, Military, and Volunteer Forces of Her Majesty's colonies under the immediate control of the British War authorities and the Government of England; (2) that these Colonial forces be recognised and enjoy all the rights and privileges of Imperial officers and men; (3) that it is desirable that an alternate telegraph cable entirely under the control of the British Government be constructed from England *viâ* the Cape of Good Hope to Australia and from thence up to India, so that in the event of war communication may be kept up with Her Majesty's colonial and Indian possessions should the Red Sea cable be interrupted; (4) to carry out the foregoing resolutions, it is desirable that communications be opened up by Her Majesty's Government with the Australasian Governments in order to obtain their views on the subject, and to ascertain whether they are willing to continue their present contributions for colonial defence forces if placed under Imperial control.

We think it very improbable that any such cable as that proposed will be laid for some considerable time at all events. The circumstances of ground and weather render almost necessary two cables, and a large subsidy would be required by any company embarking on the enterprise. Mr. Henniker Heaton, who was a delegate for Tasmania at the recent Telegraph Conference at Berlin, seems to propose that the working, &c., should be entirely in Government hands. This might do in war time, but would not answer in peace.

In answer to Mr. Hutton, in the House of Commons last week, Mr. O. Morgan said: I am informed that the West African colonies are to contribute £5,000 a year to the subsidy, to be paid to the African Direct Cable Company, and the Colonial Office proposes that this contribution should be divided among the four colonies Sierra Leone, Gambia, Gold Coast and Lagos, on the following scale, roughly proportioned to their revenues: Sierra Leone, £1,300; Gambia, £550; Gold Coast, £2,200; Lagos, £950. The fifth settlement mentioned in the contract is the Niger territory, but there can be at present no question of its contributing towards the subsidy, as no system of Government or Revenue has yet been established there. The contribution of £5,000 from the four colonies has been fixed irrespective of any sum which may hereafter be received on account of the Niger territory.

Is it not time that our Government should attend with a little more interest to British possessions in West Africa? The French have already got behind us on the Gambia, and in their advance from the Senegal River to the Niger they will tap all the traffic from the interior. They have already settled themselves on the Niger, where they have a gunboat; and both Germans and French are doing their best to cut us out at the mouths of the Niger. The French have also established themselves at Konakri, a little to the north of Sierra Leone, and it is well known they are actively intriguing with the native tribes surrounding the latter settlement. On the Congo we are left out in the cold. The French have already a cable to Konakri, and this facts lends some importance to their action in that neighbourhood. The trade of Bathurst (Gambia) is almost entirely in French hands.

Fatal Accidents with the Birmingham Steam Tram.—Two fatal accidents occurred on Monday on the Birmingham and Midland Tramways between Spon Lane and Smethwick. Finding the work of conveying a car too much for a single engine, in consequence of the heavy snowfall, the engine of a succeeding car was called in aid. Near the Blue Gates, Smethwick, about 10 o'clock, Geo. Wall, engine driver, was engaged in coupling the rear engine when the draw bar broke, and allowed the engine to come close, and in so doing crushed him so badly that death was instantaneous. Within ten minutes the same arrangement was being carried out about 200 or 300 yards further on, Joseph Pinnow, aged about 20, labourer, being between the car and engine coupling, when the draw bar slipped out of its place, and the engine closed up and crushed his head so as to cause instantaneous death.

Painting Electric Light Fittings.—The Lancashire and Yorkshire Railway Company is advertising for tenders for painting and varnishing electric light pulleys and fixings at Manchester and Batley. Applications should be made to Messrs. Bagshaw and Sons, engineers, Batley.

Self-Induction in Electrical Conductors.—We cordially endorse the remark made by Mr. W. H. Preece, F.R.S., who says that the paper recently read by Prof. Hughes, as the presidential address to the Society of Telegraph Engineers and Electricians, is the best yet brought before that body.

The Spiral Telephone Wire.—Notwithstanding the faint meed of praise bestowed upon this rifled or spirally-grooved wire by Prof. Silvanus Thompson at the meeting of the Society of Telegraph-Engineers and Electricians, last week, it is within the knowledge of our readers that, for practical purposes, tests showed it to be valueless as an improvement upon existing lines.

Secondary Batteries.—Respecting the note on this subject in our last week's issue, extracted from an article in the *Electrical Engineer*, M. Hospitalier writes us to the following effect:—"I have not written a single line of the report to which allusion is made; it is, therefore, impossible that I could have expressed a favourable or unfavourable opinion upon the secondary battery of Mr. FitzGerald. In fact, there has been no report. I consider the use which he has made of my name in these circumstances unjustifiable, and I beg you to inform your readers of this."

The Snowstorm and the Wires.—Mr. R. E. Hulton, of the Northern Telephone Company, writes us that in his district the weather during the past ten days, and particularly during the last three, has been of a totally unexampled description. "The oldest inhabitant," even with the aid of his usually elastic imagination, is unable to grapple with the occasion, and can rake nothing out of the dusty corners of his memory of the bad old times that will at all compare with the present state of things. It is perhaps early to boast yet, but with about 3 feet of snow on the ground it is probable that the worst of it is over, and therefore it is very satisfactory and reassuring to the managerial mind to have no reports of broken wires, even on the trunk routes, where the wires are exposed to the full strength of the storm. The snow has come at a very unfortunate time, as there are several important trunk lines under construction at present, and it is very necessary to get the link between Sunderland and Hartlepool complete with as little delay as possible, while the trunk between Hartlepool and Stockton is nearly completed.

The Manufacture of Incandescent Lamps.—The paper of M. Felix Lucas, which may be found on page 206, probably contains items of interest to the incandescent lamp manufacturer who aims at perfecting a vacuum.

King's College Engineering Society.—At a meeting of this society on Tuesday, February 16th, Mr. Saunders read a paper on "Dynamos." The author commenced by defining a dynamo-electric machine. He then reviewed the various methods of winding, referring especially to the principles and effect of shunt winding, and also explaining the combination of series and shunt coils to obtain constant difference of potential. Mr. Saunders next described the different machines in use, taking in turn several well-known types, and pointing out the merits and details of construction of each. The author dwelt at some length on the Edison-Hopkinson dynamo, noticing particularly the improvements which it embodies, both electrically and mechanically, on its American prototype. The dynamos of the following were also described, Siemens, Crompton, Kapp, Gramme, Brush, Shuckert-Mordey, Weston, Paterson and Cooper, Joel, Parker-Elwell, Thomson-Houston, Hochhausen, and Hopkinson's Manchester dynamo. The paper was profusely illustrated by diagrams clearly setting forth the various methods of winding, and the shape, disposition, and relative magnitude of the parts of the various machines.

West London School of Telegraphy.—The partnership between Messrs. Lynd and Cronin, in the proprietary of the West London School of Telegraphy, terminated on the 18th ult., and Mr. Wm. Lynd is now the sole proprietor of the establishment.

Electric Alarms and Indicators.—Mr. Albert has written in reply to the letter of Messrs. Thurkle & Co. on this subject, which appeared in our last week's issue; but his reply contains allusions of a personal character, and, as the matter is so unimportant, we cannot give it space. Moreover, Mr. Albert is not well posted in the relations existing between Messrs. Thurkle and Co. and his employers.

The Society of Telegraph-Engineers and Electricians.—A meeting will be held at the Institution of Civil Engineers, 25, Great George Street, S.W., on Thursday, March 11th, when Profs. W. E. Ayrton, F.R.S., and John Perry, F.R.S., members, will read papers on "Economy in Electrical Conductors," and "A Note on Magnetic Resistance."

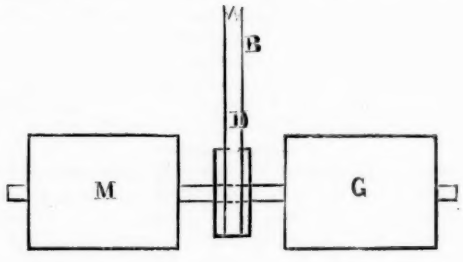
United Telephone Company's Assessment.—The *City Press* states that the United Telephone Company has appealed against the assessment of its property in eighty-six City parishes, and has obtained a reduction of the gross value from £1,000 to £740, and of the net ratable value from £834 to £625. The appellants have had to pay £20 towards the costs of the respondents.

American Papers on Electrical Subjects.—We are indebted to the courtesy of the *Electrical World* for advanced proofs of the articles which were read at the meeting of the National Electric Light in Baltimore, several of which we reproduce in this issue of the REVIEW. The papers do not, as a rule, appear to possess any scientific value, but they are practical and readable.

The Distribution of Electricity.—We have received a letter on the subject of the lecture recently delivered by Professor George Forbes before the Society of Arts. As it contains a diagram, we are compelled to hold it over till next week.

Dynamo Testing.—We shall be pleased to learn the opinions of our readers upon the method of testing dynamos as suggested by Dr. Hopkinson. It is of course well known that transmission dynamometers are not to be trusted for accurate results when used alone, but we consider that when used in combination with a Prony brake (the dynamometer when driving a dynamo at a given speed and delivering measured electrical work, indicates on its scale a certain pull, which pull can be reproduced when the Prony brake is attached to the dynamo and the mechanical work measured at the same speed), the tests may be relied upon. Moreover, unless two dynamos are at one's command Dr. Hopkinson's method cannot be applied.

The diagram shows how the two machines are connected together and driven. G represents the generator, M the motor, B the belt from the engine, and D the coupling which also serves as a driving pulley.



During the tests made with these machines a current of 521 ampères was passed through the two armatures, in order to test their mechanical strength, this current being nearly double that for which the machines are designed. The machines were found to carry this current with perfect ease, without any sparking at the brushes or displacement of the wires of the armatures. Such a current maintained for any length of time would lead to undue heating of the armature, but the fact is of importance as showing that a momentary short-circuiting of the machine would not result in serious mechanical damage to the armature, and especially that when the machines are used for transmission of power for a short time they are capable of giving about double the output required of them for regular working. In connection with locomotive power, this is a matter of vital importance as up a short incline or in starting of the cars a far greater tractive force is required than in normal working. The dynamos above described and tested are intended for the extensive new tobacco manufactory of Messrs. W. D. and H. O. Wills, of Bristol. While passing through the works of Messrs. Mather and Platt, the party inspecting the experiments, consisting of Mr. Shapcott, representing the Admiralty, Prof. Schuster, F.R.S., Mr. Webb, of Crewe, Mr. Kapp, Mr. Preece, and other scientific gentlemen, and the representatives of the technical press, were shown a large Edison-Hopkinson dynamo for an output of 50 volts 1,000 ampères at a speed of 350 revolutions, intended for electro deposition. This is probably one of the largest machines ever built for such a purpose.

We hope to have something further to say upon this matter in an early number.

Railway Electric Lighting.—A new company has been formed, under the title of the Railway Electric Lighting Company, to take over the patents and business of the Railway Electrical Contractors, Limited, which was registered with a capital of £25,000 in March, 1884. The capital of the new company is to be £130,000 in 26,000 £5 shares; 20,000 shares were offered to the public, and all of these had, we are informed, been subscribed for by the middle of the week. The terms of purchase of the business, goodwill, patents and property of The Railway Electrical Contractors, Limited, are the payment of £12,000 in cash, the allotment of 1,200 shares of £5 each of the new company, credited as fully paid up, and 4,800 shares of £5 each, credited with £2 10s. per share as paid. The vendor company, in addition to selling to the new company the existing patents for Great Britain and foreign countries, and the rights and property above mentioned, will pay all the expenses of the formation, registration, and the issue and placing of the

capital of the company up to allotment. The light has been a much appreciated adjunct to travelling by the Brighton Company's line for more than two years past. The light is also in successful operation on the South-Eastern Railway. A testimonial from Mr. G. H. Calcraft, of the Board of Trade, is embodied in the prospectus. We wish the company success in its operations.

The Ball Dynamo.—News from America reaches us to the effect that much business is now being carried on in the States and Canada in electric lighting with the Ball system. Over 2,000 arc lamps and 100 dynamos were in use, exclusive of those in Canada, at the beginning of this year. It will be remembered that the Ball machine, from its peculiar construction, into which it apparently fell by a series of misunderstood circumstances, was looked upon as an uncanny apparatus by the majority of English electricians; one, indeed, of the highest eminence, declaring his inability to understand how it should produce any current at all. One of these dynamos was tested by the late Robert Sabine in 1883, and another by ourselves at Silvertown in the following year; the results in both cases compared favourably with those of other machines in the market. For some reasons, still unexplained, this dynamo was not taken up in England, notwithstanding the very low cost of its construction. The superintendent of the Ball Electric Manfacturing Company, writing to us on the 12th February, refers to some tests made by Prof. Anthony, of Cornell University, with a so-called unipolar machine. He says:—"He has made them, but finding so much more in the machine than he expected, wants to make still more exhaustive tests. He will do this now in a few days, and you shall have a copy of the results when received. The Ball was the first machine tested by the Mammoth galvanometer at Cornell. He made the total conversion 92·3 per cent., and the commercial efficiency 78 per cent., which, as you see, agrees well with the Alabaster-Gatehouse report at Silvertown." The data contained in this report can be found in the REVIEW for May 17th, 1884. We may, however, add that the average of three tests gave for conversion 92·33 per cent., and as energy appearing in external circuit, 78·13 per cent. These figures are almost identical with those found by Prof. Anthony.

City and Guilds of London Institute.—Following is a syllabus of Prof. Ayrton's course of six lectures at the Central Institution, Exhibition Road, S.W., on some of the industrial applications of electricity. March 12th.—"Electric Lighting." The lighting of houses, streets, trains, ships, lighthouses and large areas with arc and incandescent lamps. Cost of electric lighting compared with that of using gas or oil. Construction and regulation of arc lamps. Current, potential difference, electromotive force, resistance and electric power. Mode of measuring electric power. Cost of a watt hour. Candle-power and efficiency of lamps. Mode of measuring. Life of incandescent lamps. Most economical potential difference to use with incandescent lamps. March 19th.—"Electricity as a Motive Power."—Construction and action of an electro-motor. Starting, stopping and reversing. Power and efficiency of a motor. Mode of measuring. Effect of the speed on the power and efficiency. Action of an electro-motor compared with that of a dynamo. Governing of motors to run at constant speeds. Alternate current motors. Practical examples of machinery driven by electro-motors. March 26th.—"Electric Storage of Energy." Accumulators. Power, weight and efficiency. Mode of measuring. Life of accumulators. Use of accumulators as regulators. Use as converters of electric power supplied with high potential difference and small current into power supplied with low potential difference and large current. April 2nd.—"Electric Transmission of Power." Waste of power in the conductors. Advantages and disadvantages of the parallel system of supplying electric power. Economy effected by the use of the series, or the parallel-series system. Most economical size of conductors. Heating of conductors. Uniform potential difference or uniform current along the mains. Use of accumulators, secondary generators, and motor-dynamos, in electric transmission of power. Utilisation of natural sources of power. Practical results already obtained with electric transmission. Comparison of electric with hydraulic and wire-rope transmission of power. April 9th.—"Electric Meters." Principles employed in constructing meters to measure current electromotive force, resistance and power. Direct reading meters. Common faults in existing meters. Meters to record the total quantity of electricity, or the total amount of electric energy. Equitable modes of regulating the price of electric energy. April 16th.—"Electric Locomotion." Tramcars carrying a store of electric energy. Electric launches. Methods of conveying electric power to moving vehicles. Electric, steam, horse and wire-rope traction. Absolute blocking with electric railways. Telpherage. Probable future developments in the applications of electricity.

NEW COMPANIES REGISTERED.

Railway Electric Lighting Company, Limited.—Capital £130,000 in £5 shares. Objects: To acquire the patents, property, goodwill, undertaking and assets of the Railway Electrical Contractors, Limited. Signatories (with one share each): *Sir Daniel Cooper, Bart., 6, De Vere Gardens; *F. Green, 13, Fenchurch Avenue; *M. A. Laing, 5, Cambridge Gate, N.W.; *E. Villiers, 5, Breehin Place, Gloucester Road; F. R. E. Hersee, 50, Leyland Road; W. J. Crozier, New Malden, Essex; E. G. Farish, 24, Coleman Street. Directing qualification 100 shares. The first directors are the signatories denoted by an asterisk, and Major Charles Hy. Strutt; remuneration £700 per annum. Registered 27th ult. by Norton, Rose & Co., 24, Coleman Street.

Byng Telephone Company, Limited. — Capital £5,000 in £10 shares: Objects: To purchase and work the patented invention called the Byng Acoustic Telephone and Lee Guide, with power to acquire any other mechanical telephone or license to use the same. Signatories (with one share each): W. J. Harrison Ryder, C. Stewart Lindsay, M.E., A. F. Ball, J. P. Spencer, C.E., J. Owen-Vernon, M.E., J. H. Armstrong, all of Newcastle-on-Tyne, and J. Tennant of Gateshead. The management of the company will be in accordance with Table A of the Companies' Act, 1862. Registered 25th ult. by R. Jordan, 120, Chancery Lane.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

West London Electric Lighting Company, Limited.—The returns of this company for 1884, 1885 and 1886, were filed on the 25th ult. The last of these, made up to the 3rd ult., shows that of the nominal capital of £60,000, in £10 shares, only 175 shares have been taken up, and upon these no call has yet been made.

William Elmore, Limited.—At an extraordinary general meeting of the shareholders in this company, held at the offices, 24 to 28, Charlotte Street, S.E., on the 17th December, several alterations were authorised to be made in the articles of association. The special resolution was confirmed on the 16th January, and duly filed on the 26th ult.

International Electric Company, Limited.—An order of the Chancery Division of the High Court of Justice, dated 13th ult., directs that the voluntary winding up of this company be continued, but subject to the supervision of the Court, and all creditors, contributories and liquidators of the company, and all other

persons interested therein, are to be at liberty to apply to the Judge at Chambers as there may be occasion.

West African Telegraph Company, Limited.—An order of the Chancery Division of the High Court of Justice, dated 13th ult., directs the reduction of the capital of this company to £40,000, in £10 shares, in accordance with the resolution passed at an extraordinary general meeting held on 19th January, and confirmed on the 5th ult.

Simplex Electrical Syndicate, Limited. — The registered office of this company is at 9, North Street, Wandsworth, Surrey.

Continental Etève Engine Company, Limited.—At an extraordinary general meeting of this company, held at 15, New Broad Street, on the 2nd inst., it was resolved that clause 12 of the articles of association be annulled, and the following clause inserted instead: "12. The allotment of shares shall be made by the company, and it shall commence business only upon 5,000 shares in the capital of the company being subscribed for, and the sum of not less than 10s. per share being paid thereon. Simultaneously with the transfer of the patents (or such as have been already granted), to be acquired by the company under the contract referred to in article 6, or under the agreement modifying the terms thereof, and of the right to such patents as are not yet granted for countries mentioned in the agreements, the allotment of the said 5,000 shares, and the shares to be allotted in respect of the purchase of the said patents shall be made, and the regulations for the management of the company shall be in force in respect to shares subscribed for and allotted in like manner as if the whole of the shares into which the nominal capital is divided had been subscribed for and allotted." This resolution was confirmed 17th ult., and duly filed on the 27th ult.

CITY NOTES, REPORTS, MEETINGS, &c.

Telegraph Construction and Maintenance Company, Limited.

THE 22nd ordinary general meeting of this company was held on Tuesday at the office, 38, Old Broad Street, Mr. Philip Rawson presiding.

Mr. William Shuter, the manager, having read the notice convening the meeting, and the minutes of previous meetings,

The Chairman said the shareholders would regret as much as he did that their worthy chairman was not present. About an hour before the meeting was to take place, the directors received a note from him to the effect that his doctor would not allow him to go out. They had no reason to suppose that he was seriously indisposed, but, in consequence of the severity of the weather, his medical adviser thought it prudent to keep him at home. He might mention as an interesting fact that Sir Daniel Gooch had presided at 45 consecutive meetings of the company; this was the first meeting at which circumstances had compelled him to be absent. It was a much easier task to preside where a company was prosperous, and he might fairly say, he thought, that their company had been very prosperous, and upon this he sincerely congratulated them. The report and figures were drawn up exactly on the same lines as they had been accustomed to receive them, and there was really very little for him to say. The accounts showed a profit of £82,740, and adding to that £72,166 brought forward from last year, they had a total of £154,907 to be dealt with, and that enabled them to declare the usual dividend of £1 16s. for the half year, making 20 per cent. for the year, and to carry forward the substantial sum of £65,267. With regard to the operations of the year, it was within their knowledge that early in 1885 the Government entered into a contract with the company for 1,000 miles of cable. However, it was not required, but the cable was manufactured and paid for. The company also manufactured 322 miles of cable for the Government and laid it from Shanghai to Port Hamilton, a new coaling station off the coast of Korea; that was also paid for. Then 740 miles had been manufactured for the Eastern and South African Company, being the second cable laid on that section. The Heligoland-Cuxhaven cable had been partially relaid, and brass-ribboned to resist the attacks of the teredo, a little insect which caused a great deal of mischief in submarine cables. The cables connecting the Fastnet Rock and the *Sunk* lightship with the land had been successfully maintained, with slight interruptions. These were experiments, and, particularly in the case of the *Sunk* lightship, they had had great difficulty at first in keeping up communication, but their electricians and engineers had now, he believed, got over the difficulties, and at the date of the report communication with the *Sunk* lightvessel had been maintained for 306 days out of 311. In addition to what he had already stated, they had manufactured 763 miles of cable for various telegraph companies and Colonial Governments. The *Calabria* and *Kangaroo*, which had been chartered by the Government, had been discharged and both were now in the Thames. He might mention that with regard to future work, they were manufacturing 550 miles of cable for the Eastern Company, to be laid between Singapore and Penang. There was also a considerable contract pending for 2,000 miles of cable for the African Direct Cable Co. There was nothing further calling for notice, and he would move: "That the report and accounts of the directors to the 31st December, 1885, submitted to this meeting be and the same are hereby received and adopted, and that a dividend of £1 16s. per share, in addition to the 12s. per share paid as interim dividend to 30th June, 1885, be paid on all shares of the company for the year ending December 31st, 1885, and that such dividend be paid free of income tax."

Mr. George W. Campbell seconded the resolution.

Mr. William Abbott said he was expressing the unanimous feeling of the shareholders when he regretted the absence of Sir Daniel Gooch. There was one matter respecting which the shareholders would like to hear something, but on which the report was silent; that was the important matter of electric lighting. There was no doubt that this company held the foremost position with regard to cables and everything electrical. They had done well, they had large capital, experienced officers, men of high training, eminent electricians, and therefore he was anxious to know why it was that electric lighting was standing still. Was it that Mr. Chamberlain's Bill had completely broken down this enterprise? When they heard so much about the unemployed, and when they knew of the enormous capital seeking employment, it seemed strange that such an important enterprise as electric lighting, which was making extraordinary strides in every other country, should here show little sign. He believed that if any scheme which gave the capitalist a fair chance of a return after a certain period, any amount of money could be brought into the work of electric lighting. With regard to connecting Lightships, he presumed the work was entirely in their own hands, and he foresaw that this was a branch of business where there would be great development.

The Chairman said there was no doubt whatever that the Electric Lighting Act had been a very great clog upon the electric lighting industry. With regard to their own electric lighting, they had not said anything about it because it was as yet only an experiment. The installation at Paddington was not yet open, and a great variety of difficulties had arisen, but most of these had been removed. The greatest difficulty was with reference to the residents around Paddington Station, but so far as he knew, they had all been quite quiescent for a long time. What might happen when the machinery was in full swing he was not prepared to say, but hoped everything would be straightforward and right.

The resolution was then put and carried unanimously.

Lord Alfred Paget and Mr. G. W. Campbell having been re-elected directors, and Messrs. John Gane and James Glegg, auditors,

Mr. William Ford, in moving a vote of thanks to the chairman and directors of the company, said it was some years since he last had the pleasure of attending a meeting of this company, and it was a great satisfaction to him, as it must be to his co-proprietors, to know that it had survived some of the advice which in those years ago he had ventured to give to it; and they had to thank their board of directors for rejecting much of the advice he then offered, for he feared that if they had followed some of the juvenile precepts he then endeavoured to enforce on their minds, the happy results now announced would not have been secured. Whilst recanting some of the errors of his youth, he must make candid confession that he was then most strongly in favour of the utmost publicity in the reports of the company, and of communicating to the shareholders every possible tittle of information that could possiby be given. He recanted that now as an error. Many things had happened since then; important competitive establishments had grown up for the manufacture of cables, and he ventured to say that the information contained in the reports of this company too frequently gave their competitors an insight into the working of their business which it was exceedingly indiscreet for them to give. For his own part he would have excluded from the report now before them all that portion relating to the operations of the company, and would simply have said, "Various important contracts have been entered into, and successfully and profitably executed during the course of the current year." Any further information shareholders taking an interest in the affairs of the company desired they would, he had no doubt, readily obtain from their able manager, Mr. Shuter. This was simply his individual opinion; but he believed the experienced gentlemen who sat at the board would confirm him in the view which he had expressed, that in a manufacturing business of this character, having such powerful competitors, it was not always discreet to tell who their customers were, nor what amount of work they did for them. He then moved a vote of thanks to the Chairman, Sir Daniel Gooch, whose indisposition he exceedingly regretted, and the other members of the board, whose valuable services they all highly appreciated. After the lapse of so many years, it was a great pleasure to him to see that the company still enjoyed the benefit of the very able assistance which they derived from their energetic manager, Mr. Shuter; also that

they still benefitted by the skill and magnificent abilities—and he used that expression not as a mere figure of speech, but from knowledge of the gentlemen of whom he spoke—of Mr. Willoughby Smith, Mr. Clifford, Captain Halpin, and all the other employés of the company. All these were, in their particular posts, men of the highest honour and integrity, and he hoped they would continue their services for many years to the advantage of the company, and, he hoped, also to their own.

Mr. Newton, in seconding the vote of thanks, endorsed all that had been said by Mr. Ford as regarded this particular company, but contended that no company that had not achieved the splendid results of this company was entitled to the confidence of the shareholders to the extent that the latter should be content with the mere declaration of a dividend.

The vote was cordially agreed to, and the Chairman suitably acknowledged it, whereupon the meeting terminated.

Brazilian Submarine Telegraph Company, Limited.—The directors of this company have declared an interim dividend of 3s. per share, or at the rate of 6 per cent. per annum, free of income-tax, for the quarter ended 31st December, 1885, and payable on the 25th inst. The books of the company will be closed from the 18th to 24th inst., both days inclusive.

Great Northern Telegraph Company, Limited.—The interest due on the 1st inst. on Series B of the Debentures of 1883, will be paid at the offices of Messrs. C. I. Hambro & Son, 70, Old Broad Street.

London Platino-Brazilian Telegraph Company, Limited.—The interest due on the 1st inst. on the Six per Cent. Debentures will be paid by Messrs. Glyn, Mills, Currie & Co., 67, Lombard Street.

Lancashire and Cheshire Telephonic Exchange Company, Limited.—An interim dividend at the rate of 7 per cent. per annum is now payable.

TRAFFIC RECEIPTS.

The Cuba Submarine Telegraph Company, Limited. The number of messages passing over the lines of this company during the month of February was 3,402, estimated to produce £2,750, against 3,325 messages, producing £2,730 in the corresponding month of last year. The receipts for the month of November, estimated at £2,250, realised £2,313

The West India and Panama Telegraph Company, Limited. The estimated receipts for the half-month ended the 28th February are £2,485, as compared with £2,515 in the corresponding period of 1885. The November receipts, estimated at £3,935, realised £3,996.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending February 26th were £2,662, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

The Eastern Extension, Australasia and China Telegraph Company, Limited. The receipts for February amounted to £33,688, against £40,114 in the corresponding period of 1885.

The Direct Spanish Telegraph Company, Limited. The estimated receipts for the month of February were £1,576, against £1,442 in the corresponding period of last year.

The Eastern Telegraph Company, Limited. The receipts for February amounted to £48,814 against £61,784 for the corresponding period of 1885.

The Brazilian Submarine Telegraph Company, Limited. The receipts for the week ending February 26th amounted to £3,478.

PROCEEDINGS OF SOCIETIES.

The Society of Telegraph-Engineers and Electricians.

AN ordinary general meeting of this society was held on Thursday, February 25th, Mr. C. E. SPAGNOLETTI, Past-President, in the chair. The minutes of the last ordinary general meeting having been read and confirmed, and the list of new and proposed new members announced, the adjourned discussion on Prof. Hughes's paper (Inaugural address) on "The Self-Induction of an Electric Current in Relation to the Nature and Form of its Conductor," was continued.

Mr. PREECE said that when Prof. Hughes read his address he interpolated remarks to the effect that certain statements which he (Prof. Hughes) made were not of importance; those statements, however, he (Mr. Preece) did not consider to be trivial, and the same was the case throughout the paper. The latter had given rise to the best discussion that had been held for a very long period; facts which had hitherto been known only to the few were now known to the many. Self-induction has been a *bête noir* which it has been necessary to thoroughly comprehend and to master. In February, 1877, he read a paper before the Society on the subject of "Shunts;" the title of the paper he now considered to be an unfortunate one, as it did not properly express the subject dealt with, which was really that of self-induction. Owing to the excitement created by the introduction of the telephone at the time, attention had been diverted from the subject of the paper, and no more was heard of it. He had paid a great deal of attention to the subject of induction, and had tried to distinguish between and separate the two effects of electro-magnetic and electro-static induction. In the paper referred to, he had pointed out the similarity of the effects to those of inertia in mechanics. He had not attacked the subject from a mathematical but from an energetic point of view. When a current of electricity is transmitted through a wire, the immediate neighbourhood around it became a magnetic field, and if we had another wire in proximity to the first one, it became influenced by the field and absorbed part of the energy given out by the wire in question; the subject had been thoroughly considered by Faraday. Fizeau and Gounelle had pointed out that the speed of electricity in copper and iron wires was in the proportion of 180 to 100. An Italian *savant* had also showed that when an iron resistance is measured by rapidly intermittent currents the results were different from those observed when the current was stable; the exact cause was probably not understood by the discoverer, but Prof. Hughes had now made the reason abundantly clear. Referring again to his paper of 1877, he would point out that he had not attacked the question with reference to effects on telegraph wires, but with reference to the effects on instruments. The discharge currents were measured from electro-magnets much in the same way as discharges from a condenser were measured. Taking the discharge from one limb of the magnet of a Morse inker as unity, the discharges from two limbs were 1·7. When the cross piece was added on, the discharge rose to 496; and when an armature was also added, this was still further increased to 2,238. On joining the coils up for quantity, this latter was reduced, as would be expected, to 502. Three different forms of relays gave effects of 1,688, 279, and 26, respectively; the latter being the result obtained from the present Post Office standard pattern, in which there was no cross-piece. The result of induction in the case of telegraphy is a reduction in the speed of working, but by proper means this, to some extent, may be obviated; thus, in the case of the Wheatstone automatic instrument, the speed of working, which originally did not exceed 50 to 60 words a minute, had now been increased to 450. In telephonic communication the effect of induction was to produce muffling, and this effect was more due to electro-magnetic than electro-static induction. The result of using a metallic circuit, and also of twisting the wires, had been pointed out by Prof. Hughes. An experiment to determine the relative values of iron and copper wires had been made between London and Newcastle,* and practically the paper of Prof. Hughes had been the outcome of this. Between London, Manchester, and Liverpool four new iron wires had been erected, and in order to determine how far telephonic communication could be carried on, these wires had been arranged on the "twist" principle. The result, he was sorry to say, was that it was found to be practically impossible to speak from London either to Liverpool or Manchester; the speech being blurred and confused. If the wires had been of copper instead of iron, he had no doubt but that a very different result would have been obtained. Prof. Hughes had shown the effect of stranding iron wires, but he doubted whether all the results anticipated from the discovery would be what were anticipated, but even if they were the use of such wire would be impracticable. Stranded wire allowed snow to accumulate on it with comparative ease, it was not durable, and, moreover, its static inductive capacity was high; again, its resistance is high. The result of compounding copper with iron in wire was marvellous, and the results of some experiments on the subject would be communicated by Prof. Hughes, the copper seemed to act as a shunt to the iron, and to thus remove the self-induction. One method of getting rid of self-induction in telegraphy was by placing a shunted condenser between the receiving instrument and earth, the discharge from the condenser in this case cut off the "tailing" of the current. Sparking in relays was an effect of self-induction; this was, curiously enough, traced to the self-induction in galvanometers, which in the postal system were always kept in circuit with the line; on short circuiting the galvanometers the effect disappeared. With reference to Mr. Pope's remarks as to the joining up of relays in multiple arc, an explanation of the result had been given by him (Mr. Preece) in his paper of 1877. He might remark that the results obtained by Prof. Hughes had been effected by means of a few feet of wire only, whereas he himself had to determine them from a length of 278 miles (between London and Newcastle). He considered that Prof. Hughes's experiments had greatly added to the progress of electrical science, and that the paper was the best yet brought before the society. In this case, experiment as usual had gone in advance of theory.

Dr. FLEMING pointed out that the effect of self-induction in a wire could be greatly reduced by slotting it, that is to say, by making it in the form of pinion wire.

Mr. DESMOND FITZGERALD drew attention to the theories which he had formed on the subject, and which had been published by him in the "Electric Telegraph Review" of 1870. He had come to the conclusion that electromagnetic induction precedes the current, and that there was a certain period at which the inducing current ceased.

Prof. SILVANUS THOMPSON pointed out that one point in connection with Prof. Hughes's experiments seem to require clearness, and that was, that no account seemed to have been taken of the rate at which the makes and breaks were made. What would happen if, instead of a microphonic make and break, a tuning fork were used, giving, say 100 vibrations per second. He ventured to think that better results would be obtained if the makes and breaks were made in this way. The effect of self-induction could be expressed by the equation

* ELECTRICAL REVIEW, Vol. XVII., page 271.

$$i = \frac{E_0}{\sqrt{R^2 + 4\pi^2 n^2 L^2}} (\sin.\ (\theta - \phi))$$

where ϕ expresses the retardation. The retardation is equivalent to a spurious resistance, so that the actual resistance of a wire could be expressed in terms of the apparent resistance and the spurious resistance. This could be graphically represented by a right angled triangle. Dr. Flemings's suggestion with reference to the slotting of wire to prevent self-induction was correct from several points of view. The Spiral Wire Telephone Company, he would point out, had, to some extent, adopted this principle. He had himself, some time ago, pointed out that iron wire was not good for telephonic purposes. Silicum bronze would be very suitable, the wire being small, so as to have a high resistance. As regards telephonic apparatus, he considered that the receiver ought to be joined in multiple arc and not in series, with the secondary of the induction coil, the primary circuit ought also to be kept open at the receiving end. The induction coils lately designed by Mr. Langdon Davies, in which the primary and secondary wires were wound side by side, ought to be highly efficient. As regards spurious resistances, a layer of powdered carbon offered such a resistance. The principle was adopted in Varley's lightning protector, but the idea was wrong.

Prof. AYRTON said that the mutual effect of currents on each other, as well as on themselves, ought to be taken account of in considering the question of spurious resistances.

Prof. HUGHES, having briefly replied, stated that he would reserve his principal remarks and have them printed in the Journal of the society, they being too lengthy to give on the present occasion.

The meeting then adjourned.

Physical Society, February 13th.

ANNUAL GENERAL MEETING.

Prof. F. GUTHRIE, President, in the Chair.

Prof. T. H. Huxley and Mr. A. E. Mills were elected members of the society.

The PRESIDENT read the report of the council.

The TREASURER, Dr. E. Atkinson, presented his report, which was adopted.

The meeting resolved that votes of thanks be accorded to the committee of the Council of Education; the president and officers of the society; the auditors of the society's accounts.

The meeting then proceeded to elect officers for the forthcoming year, and a ballot having been taken, the following were declared elected:—President, Dr. Balfour Stewart, LL.D., F.R.S.; Vice-Presidents, Dr. J. H. Gladstone, F.R.S., Prof. G. C. Foster, F.R.S., Prof. W. G. Adams, F.R.S., Sir W. Thomson, D.C.L., F.R.S., Prof. R. B. Clifton, M.A., F.R.S., Prof. F. Guthrie, Ph.D., F.R.S.; the above have filled the office of president. Prof. W. E. Ayrton, F.R.S., Shelford Bidwell, M.A., LL.B., Prof. H. McLeod, F.R.S., Prof. W. Chandler Roberts-Austen, F.R.S. Secretaries, Prof. A. W. Reinold, M.A., F.R.S., and Walter Bailey, M.A. Treasurer, Dr. E. Atkinson. Demonstrator, C. Vernon Boys. Other members of council, Conrad W. Cooke, Prof. G. Forbes, F.R.S.E., Prof. F. Fuller, M.A., R. T. Glazebrook, M.A., F.R.S., J. Hopkinson, D.Sc., F.R.S., Prof. J. Perry, F.R.S., Prof. J. H. Poynting, M.A., Prof. A. W. Rücker, M.A., F.R.S., Prof. S. P. Thompson, D.Sc., C. R. Alder Wright, D.Sc., F.R.S.

Prof. GUTHRIE, in resigning the position of president, thanked his colleagues for the help they had afforded him since he became president of the society in 1884; he also congratulated the society upon the highly satisfactory state to which it had attained.

The meeting then resolved itself into an ordinary meeting.

In the absence of the president, Prof. Balfour Stewart, the chair was occupied by Prof. G. C. FOSTER.

The following communications were read:—

"On Experimental Error in Calorimetrical Work," and "On Delicate Calorimetrical Thermometers." By Prof. U. S. PICKERING. In conducting a great number of determinations of the heat of dissolution of a solid body in water, the author has had an opportunity of detecting the sources of error incident on such work, and by an examination of the results has not only obtained the mean error of a series of observations, but has been able to apportionate this error to its various causes. In the experimental work it was found that the presence of anything but air between the calorimeter and jacket was most injurious; the space should be entirely open and no cover of any sort should be used. Before reading the thermometers, as pointed out by Berthelot, the top of the stem should be tapped for some time, otherwise the mercury lags behind the true temperature; but besides this thermometric error, which the author calls the "temporary error," is another effect which may be termed the permanent error, of a similar kind, which no amount of tapping will remove. He has found and verified by special experiments that a thermometer when rising is invariably too low, while when falling it is invariably too high. Error due to this, which varies in amount with different instruments, is avoided by conducting the whole experiment with a rising or with a falling thermometer. The thermometers employed in these experiments had a range of 15° C., and a total length of 600 mm. The experiments were performed at temperatures varying from 1° to 26° C., and as it was important that the same thermometer should be used in different experiments, and even advisable to use the same part of the scale of the thermometer, the following expedient was devised:—

The thermometer was first heated to the highest temperature required in the experiment, and by the application of a flame to the mercurial column, just below the enlarged space at the end of the tube, that part of the mercury above the flame was broken off and driven into the space, where it remained when the thermometer was cooled. By this means the relative value of a scale division was only inappreciably affected, while the absolute value could be obtained from a single comparison with a standard. From an examination of the results obtained, the author concludes that for further accuracy in this kind of work we must look for improvements in the methods employed, the instruments having, he believes, attained to a state as near perfection as possible.

"On Some New Forms of Calorimeters." By Prof. W. F. BARRETT. These instruments were constructed for the accurate and ready determinations of specific heats, notably those of liquids. In the first form the bulb of a thermometer is blown into the form of a cup, of about 4 cc. capacity, which thus acts as a calorimeter. Into this cup the liquid is dropped directly from a burette, its temperature being observed by a thermometer in the burette, the mouth of which is closed by the end of the bulb of the thermometer, which is ground, and thus acts the part of a stopper, so that on raising the thermometer, the liquid flows from the burette into the cup. The thermometer itself forms a balance, the horizontal stem acting as the beam is supported by a knife edge, and a pan is attached to the further end, by the addition of weights to which the weight of liquid added can be ascertained. In the second form, a simple thermometer with a large bulb is used, the latter dipping into a silver vessel into which the liquid is introduced as before.

Prof. S. P. THOMPSON exhibited a glass calorimeter, similar in construction to that of Favre and Silbermann; water is used instead of mercury, the great density of which renders it unsuitable for use in so large a glass vessel.

FEBRUARY 27TH, 1886.

Dr. J. H. GLADSTONE in the Chair.

Dr. Sydney Young and Mr. D. E. Jones were elected members of the Society.

The following communications were read:—

"The Relations of Pressure, Temperature and Volume in Saturated Vapours, by Prof. W. C. UNWIN. In the first part of this paper certain formulæ given by Messrs. Ramsay and Young in a recent communication on "Some thermodynamical relations," are criticised. The most important of these is the statement that for different saturated vapours at the same pressure $p \frac{dp}{dt}$ is constant. Prof. Unwin finds, however, that $t \frac{dp}{dt}$ is less constant than $t^2 \frac{dp}{dt}$, while $\frac{t^2}{p} \frac{dp}{dt}$ is nearly a constant quantity for all saturated vapours under any conditions. This result suggested that $\frac{t^{n+1}}{p} \frac{dp}{dt}$ might be more nearly constant, and the integration of this gives

$$\log p = a - \frac{b}{t^n}$$

a formula to the examination of which the second part of the paper is devoted. From it may be derived the following relations in which for convenience in calculation the logarithms given are to the base 10.

$$t = \left(\frac{b}{a - \log. p}\right)^{\frac{1}{n}}$$

$$\frac{1}{p} \cdot \frac{dp}{dt} = 2{\cdot}3025 \frac{n\,b}{t^{n+1}}$$

$$= 2{\cdot}3025\ n \frac{(a - \log. p)^{\frac{n+1}{n}}}{b^{\frac{1}{n}}}$$

$$\frac{t}{p} \cdot \frac{dp}{dt} = 2{\cdot}3025 \frac{n\,b}{t^n}$$

&c.

These formulæ have been examined in the case of steam from − 30° to 230° C., and with pressures varying from ·4 to 20·000 mm. The constants were found to be

$$a = 7{\cdot}5030 \qquad b = 7579 \qquad n = 1{\cdot}25$$

and the differences between the calculated results and the observations of Regnault and Zeuner rarely exceeded one per cent., while generally much smaller. a, b and n have also been found for some other substances with the following results:—

Alcohol ...	$a = 7{\cdot}448$	$b = 8784$	$n = 1{\cdot}29$
Ether ...	$a = 6{\cdot}9968$	$b = 3047$	$n = 1{\cdot}153$
Mercury ...	$a = 9{\cdot}8651$	$b = 597{\cdot}5$	$n = {\cdot}69$
Carbonic acid	$a = 8{\cdot}4625$	$b = 302{\cdot}8$	$n = {\cdot}77$

Prof. PERRY offered some criticisms upon this paper, and believed that for practical purposes the expressions given would not be found superior to Rankine's formula

$$\log. p = a - \frac{b}{t} - \frac{c}{t^2}$$

which gives p in terms of t, and a quadratic expression for obtaining t in terms of p. He also observed that the chief aim of Ramsay and Young's paper was to obtain relations between the

pressure and temperature of different saturated vapours, so that the connection between temperature and pressure having been observed and recorded for one vapour, that for any other vapour could be at once deduced from it.

"On a Map of the World in which the Proportion of Areas is Preserved," by Mr. WALTER BAILY. The author had devised a method for constructing such a map, but has subsequently found that one precisely similar was employed by Flamsteed in 1729 for charting the stars in his "Atlas Coelestis." The construction applied to the earth is briefly as follows:—Draw a straight line to represent the meridian that is to occupy the centre of the map. Divide this line into equal parts, representing upon a convenient scale the distance between the parallels of latitude, and through these points draw a series of lines at right angles to the original line; these are the parallels of latitude. Mark off on these the actual distances at which the meridians cut them; through the points so found the meridians may be filled in and the map constructed. From the method of construction it is evident that, although the outlines in the map are distorted, the amount of distortion increasing with the distance from the central meridian, the proportionality of areas is preserved, a fact which the author believes will render the map useful for recording rain-fall, depth of sea, ocean currents, &c.

"On a delicate Calorimetric Thermometer," by Prof. S. U. PICKERING.

Royal Society, January 21st.

"On the Clark Cell as a Standard of Electromotive Force." By LORD RAYLEIGH, M.A., D.C.L., Sec. R.S.

This paper, supplementary to that "On the Electrochemical Equivalent of Silver, and on the Absolute Electromotive Force of Clark Cells" (*Phil. Trans.*, part 2, 1884), gives the further history of the cells there spoken of, and discusses the relative advantages of various modes of preparation. The greatest errors arise from the liquid failing to be saturated with zinc sulphate, in which case the electromotive force is too high. The opposite error of *super*-saturation is met with in certain cases, especially when the cells have been heated during or after charging. Experiments are detailed describing how cells originally supersaturated have been corrected, and how in others the electromotive force has been reduced by the occurrence of supersaturation consequent on heating. If these errors be avoided, as may easily be done; if the mercury be pure (preferably distilled *in vacuo*); and if either the paste be originally neutralised (with zinc carbonate), or a few weeks be allowed to elapse (during which the solution is supposed to neutralise itself), the electromotive force appears to be trustworthy to $\frac{1}{1000}$ part. This conclusion is founded upon the comparison of a large number of cells prepared by the author and by other physicists, including Dr. Alder Wright, Mr. M. Evans, Dr. Fleming, Prof. Forbes, and Mr. Threlfall.

As regards temperature coefficient, no important variation has been discovered in saturated cells, whether prepared by the author or by others. In all cases we may take with abundant accuracy for ordinary applications—

$$E = 1{\cdot}435 \left\{1 - 0{\cdot}00077\ (t - 15^\circ)\right\},$$

the temperature being reckoned in Centigrade degrees. For purposes of great delicacy it is advisable to protect the standards from large fluctuations of temperature. Under favourable circumstances two cells will retain their relative values to $\frac{1}{10000}$ for weeks or months together.

Unless carefully sealed up, the cells lose liquid by exudation and evaporation, and then the electromotive force gradually falls. Marine glue appears to afford a better protection than paraffin-wax, and there seems to be no reason why cells thus secured should not remain in good order for several years.

In cells of the H-construction (§ 29 of former paper), the leg containing the amalgam (but not the one containing pure mercury) is liable to burst, apparently in consequence of a tendency to alloy with the platinum. Protection with cement of the part of the platinum next the glass has been tried, but no decisive judgment as to the adequacy of this plan can as yet be given.

Recent cells, intended for solid zincs, have been made of a simplified pattern—nothing more, in fact, than a small tube with a platinum wire sealed through its closed end. The zincs are not recast, and the paste is prepared from (unwashed) mercurous sulphate rubbed up in a mortar with *saturated* solution of zinc sulphate and a little zinc carbonate. A stock of paste may be prepared and retained for use in a bottle.

Experiments are described tending to prove that the irregularities observed during the first few weeks of the life of a cell prepared with acid materials have their origin principally at the mercury electrode.

Cells prepared with dilute solutions have a lower temperature coefficient (about 0·00038), but would be more difficult to use as standards, whose value is to be inferred from the mode of preparation.

Details are given of H-cells charged with amalgams of zinc and mercury in both legs, without mercurous sulphate. A very small proportion of zinc is sufficient to produce the maximum effect. Pure mercury, neither alloyed with zinc nor in contact with mercurous sulphate, has an uncertain electromotive value.

Since the comparison of cells does not absolutely exclude a small general alteration of electromotive force with age, further determinations of the standard cell (No. 1) have been effected by means of the silver voltameter. The results—

TABLE XVIII.

Date.	E.M.F. of No. 1 at 15° C. in B.A. volts.
October 1883 to April 1884	1·4542
November 1884	1·4540
August 1885	1·4537

are very satisfactory, and indicate a constancy sufficient for almost all practical purposes.

Finally, some comparisons are given between Clark cells and Daniells, with equi-dense solutions, both of Raoult's pattern and of that described recently by Dr. Fleming.

NEW PATENTS—1886.

2668. "Electrical annunciators used for telephonic purposes." J. POOLE, D. SINCLAIR. Dated February 24.

2692. "Electric switch." I. PROBERT. Dated February 24.

2698. "Electric lighting." J. ROPER. Dated February 24.

2701. "Chandeliers and pendants for electric lights." W. F. STANLEY. Dated February 24.

2704. "Dynamo-electric machines." A. THOMPSON, J. G. W. FAIRBAIRN. Dated February 24.

2759. "Telephonic apparatus." D. SINCLAIR. Dated February 25.

2760. "Applying electricity for therapeutic purposes." A. H. BYNG. Dated February 25.

2773. "Voltaic batteries." A. M. CLARK. (Communicated by C. R. Goodwin.) Dated February 25.

2776. "Self-regulating electric portable battery." H. R. FISHER. Dated February 26.

2783. "Electro-motors for the propulsion of tramcars, electric locomotives, vehicles, &c." A. J. JARMAN. Dated February 26. (*Complete.*)

2785. "Safety electric lamp for coal miners." W. J. SMITH. Dated February 26.

2824. "Making carbons of incandescent electric lamps" G. DAVIDSON, R. C. JACKSON, J. B. DUNCAN. Dated February 26.

2834. "Electric signalling instruments." T. B. SLOPER. Dated February 26.

2874. "Apparatus or appliance for effecting the circulation of solutions in primary and secondary electrical batteries." J. MUSGROVE-MUSGROVE. Dated February 27.

2880. "Generation and utilisation of electrical energy." H. H. LAKE. (Communicated by G. E. Cabenallas.) Dated February 27.

2905. "Driving mechanism for electric tramcars." M. IMMISCH. Dated March 1.

2932. "Galvanic batteries." A. SCHANSCHIEFF. Dated March 1.

2956. "Electro-dynamo machines." M. IMMISCH. Dated March 1.

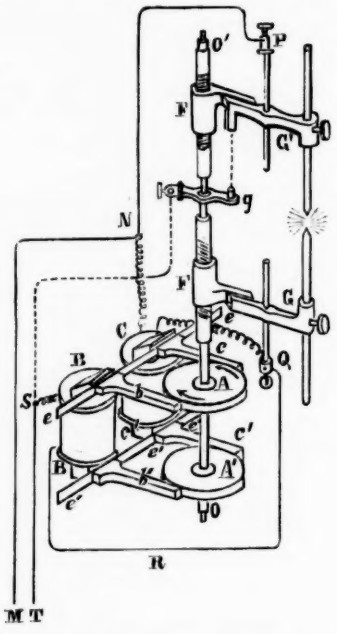
2959. "Electrical brushes." W. T. WHITEMAN. (Communicated by W. H. Miles and J. C. Aiken.) Dated March 2. (*Complete.*)

2975. "Dynamo-electric machines." N. TESLA. Dated March 2.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1885.

9666. "Improvements in electric arc lamps." C. STREET and F. V. MAQUAIRE. Dated August 13. 8d. A is a disc of soft iron fixed on a rotating axle, O. B and C are two electro-magnets, the cores of which are composed of soft iron wires or strips. *b* and *c* are two soft iron armatures made of either one massive or of more pieces, and fixed on the springs, *e*, *e*; the latter are secured on the rigid blocks, E, E, E, in such a manner that the extremities of the armatures, *b* and *c*, are tangential to the disc, A. If in these conditions an alternating, an undulatory, or an intermittent current is caused to circulate through the wires of the electro-magnets, B and C, each of the armatures, *b* and *c*, under the influence of the two antagonistic actions of the magnetic attraction of the electro-magnets, and to the elasticity of the flexible springs upon which they are mounted, become possessed of a vibratory motion. The shape given to the armatures, *b* and *c*, is that of a bar, the central line of which is parallel to the direction of the vibratory motion of the springs, *e*. A polarity is, under the influence of the poles of B and C, developed at each end of the bars, *b* and *c*. The said polarities partake of all the fluctuations, resulting from the variations, the successions or the changes in the direction of the currents circulating through the electro-magnets, B and C. The polarities thus developed in the bars, *b*, *c*, simultaneously produce

the following effects :—1. The magnetic adherence to the disc, A, and tangentially to the said disc, of the free ends of the armatures. 2. The motion of the said armatures towards the poles of the electro-magnets. A backward motion of the armature succeeds that of attraction during the period of decrease or of cessation of polarity in the electro-magnets. The adherence of the armatures to the disc then ceasing, the springs, *e*, bring them



back to their initial position without causing any motion of the disc. The result of these effects is an action, the tendency of which is to actuate the disc, A, in the direction of the arrows shown in the diagram.

12181. "An electro-magnetic revolution counter, specially applicable to ships' logs." B. FAYMONVILLE. Dated October 13. 8d Relates to a speed register, the registering of which is produced by an electro-magnetic apparatus.

12351. "Improvements in regulating apparatus for electric are lamps." G. E. VAUGHAN. (Communicated from abroad by the Austrian Small Arms Manufacturing Company, of Austria.) Dated October 20. 8d. Consists of improvements in electric arc lamps constructed as described in the complete specification of an application for Letters patent made on the 26th day of November, 1884, No. 15566.

13451. "Improved method of neutralising the residual magnetism in electro-magnets." E. G. COLTON. (Communicated from abroad by F. Haenichen, O. Haenichen, and O. Seebas, all of New York). Dated November 6. 8d. The invention consists of a method of neutralising the residual magnetism in electro-magnets by the following steps :—firstly, sending a current in one direction through the coils of the electro-magnet so as to attract the armature; secondly, sending a current in the reverse direction through the coils of the electro-magnet, so as to neutralise the residual magnetism of the cores and cause the dropping of the armature and the automatic breaking of the circuit when the complete neutralisation of the residual magnetism has taken place.

13575. "An improvement in the art of conveying articulate speech by electricity and in apparatus for that purpose." H. J. ALLISON. (Communicated from abroad by A. M. A. Beale, of New York.) Dated November 9. 8d. Consists chiefly in the use of condensers placed at each end of the main line circuit.

13998. "Improvements in electrical incubators." H. J. ALLISON. (Communicated from abroad by C. Bassini and A. Heyden, both of America.) Dated November 17. 8d. Relates to an electrical device for maintaining constant temperatures in the incubator; and contains a mercurial thermometer combined with mechanism and a damper, which damper is suitably arranged in the incubator to allow, when opened, of the escape of hot air therefrom. The mercury in said thermometer on rising to the predetermined points closes an electrical circuit, which includes a magnet, and the said magnet through its armature controls the damper. The invention also consists in the improved mechanism for turning the eggs without necessitating access to the interior of the box, and in the novel construction and arrangement of the heating and air moistening apparatus.

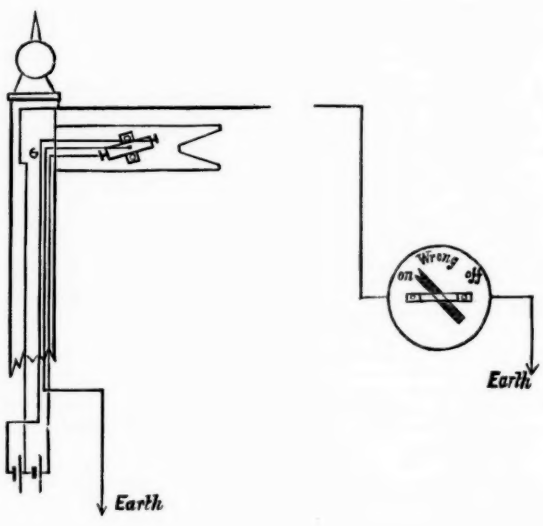
14148. "A combined electric bell and pendulum indicator." A. F. LLOYD. Dated November 18. 6d. Consists in combining the indicator with the bell, and thus rendering the use of a separate indicating apparatus unnecessary.

14851. "Improvements in and relating to lightning conductors." R. P. EIDSFORTH and F. J. MUDFORD. Dated December 3. 8d. Has reference to the means of uniting the parts of the lightning conductor together, and of securely attaching it to the building or structure to be protected from the effects of lightning.

CORRESPONDENCE.

Railway Signalling Instruments.

Can you afford me space in your columns to describe a new electrical contact maker I have recently invented for use in connection with railway signal repeaters? It is designed to be actuated by, and to record the actual position of, the signal arm or lamp, as the case may be, being quite independent of any rod or other attachment for working the signal. In the case of a semaphore signal, the contact maker is placed upon the arm itself, about midway, and securely bolted thereto, three wires are led from it along the arm to the post, and thence, one to the positive pole of a two cell battery, one to the negative pole of ditto, and one to earth. The earth wire is connected to the contact maker by means of a simple slip connector, which, in the event of the arm carrying away from the post, would draw out, thus causing an interruption in the electrical circuit, and making the repeating instrument in the signal cabin show that the arm was "Wrong." The "On" and "Off" signals are sent by the motion of the arm causing the contact to change its position from one end to the other in the contact maker, according as the arm moves up or down, and so sending the corresponding signal to the repeating instrument in the cabin by means of reversal of current.



The advantages claimed are, firstly, that the contact maker is in its proper place, *i.e.*, on the semaphore arm, and consequently registers correctly the "actual" position of that arm; whereas, in the majority of contact makers, the motion for making contact is obtained from the rod and indicates only the position of the rod, which in the event of a rupture in the mechanism, may be quite the reverse of the arm; secondly, the contacts are maintained in a clean and good working condition, being hermetically sealed, and protected from the weather; thirdly, there are no mechanically moving parts to break, wear, or get out of order. Further, the battery power being at the post, you are enabled to send reversals of current on the one line wire. By winding the coils of the repeater instrument to a high resistance, a very small battery power is made available, so avoiding all risk of oxidation of contacts, and considerably prolonging the life of the battery, and reducing the cost of maintenance.

I may add that these contact makers have been

working under my supervision on the District Railway for many months without a failure, and that a two cell battery working on the same principle, has been in continuous use for upwards of twelve months without renewal.

I shall be pleased to give further information or answer enquiries on the above.

C. Brown.

Telegraph Department, District Railway,
Victoria Station,
February 23rd, 1886.

Incandescent Lamp Tests.

The Swan Company state that their lamps have an efficiency of 3½ to 4 watts per C.P., but do not state whether this is for lamps of low or high E.M.F.

In Messrs. Woodhouse & Rawson's new pamphlet on incandescent lamps, I notice that they state their low resistance lamps require 2½ watts to the candle power, and their high resistance lamps 3 watts per C.P.

I would be glad if some of your readers could give me the benefit of their experience in the use of lamps of different electromotive forces between 50 and 100 volts, which I take to be representative of high and low E.M.F., and which are no doubt of a different efficiency according to the E.M.F.

In the Vienna tests, in which the efficiency of the Swan lamps was not published, I notice that the Woodhouse and Rawson lamps of low E.M.F. were said to be 2¼ watts per C.P., whilst in the tests of the Franklin Institute, their efficiency per spherical C.P. (the above-mentioned candle-power being measured horizontally, and candle-power of incandescent lamps being usually spoken of as horizontal) was 3½ watts. With regard to the latter tests, I believe that the lamps were of an old make, and that there was some mistake about them, the efficiency considerably improving after the first few hours' running. With regard to the Vienna tests, where the efficiency of the low E.M.F. lamps was 2¼ watts per C.P., I suppose that Messrs. Woodhouse & Rawson have found it answer better to increase the length of life of the lamps and lower the efficiency. What I would like to know, would be, taking the life of an incandescent lamp at 1,000 hours, is the efficiency of low and high E.M.F. lamps the same, and if not, what would be the efficiency of either Swan or Woodhouse & Rawson lamps of say, 50, 60, 70, 80, 90, 100, 110 volts?

Incandescence.

Sudenburg-Magdeburg, den
Westendstrasse 27,
February 25th, 1886.

Lightning Conductors and Professor Hughes's Discoveries.

It would be of much service to lightning conductor manufacturers and the public if, before the interest manifested in Professor Hughes's discoveries dies out, some more definite expression of opinion regarding conductors were announced. I therefore venture to ask, if stranded iron wire is so good, what is the real position with regard to stranded copper wire as conductors?

Of late years copper tape has been much favoured by the public, and makers of the old and patented forms have adapted their wares to the popular taste. Now, however, there is the scientific value to be added thereto, which will doubtless do much to make permanent that form, though progress in lightning conductor knowledge is slow, as witness the number that even now are fixed *with insulators*. One form of conductor, however, most strongly recommended by a high scientific authority—Mr. W. H. Preece, F.R.S.—is emphatically condemned, viz., the iron rod of No. 4 wire.

Professor Hughes's deliverance on this subject, if he could spare the time, would be appreciated by

Copper Tape.

27th February, 1886.

Telephone Patents.

Permit me, in reply to Mr. W. J. Barnard's letter in to-day's issue, to say that when I wrote my previous letter I was fully aware of the telephone instruments of Professor Thompson, as supplied by the New Telephone Company, Limited, and it was because of the fullness of that knowledge, based upon practical acquaintance, that I expressed myself as I did. But let me refer to that experience. Last year a most influential firm, who had a number of Gower-Bell telephones in use, were desirous of adding to the number of their speaking instruments, and as the Valve telephone was in the market, it was decided to give it a trial. Two complete sets were received from London, and an expert followed, who, with the help of a man placed at his disposal, fitted them up, placing a set at either end of a well-insulated short metallic circuit. When he announced that all was completed and ready for trial considerable interest was manifested, and everyone anticipated the best of results. Unfortunately, the reverse is what happened. The speech was irregular and squeaky, and during the three days of the expert's presence no good talk could be got. He was disappointed, he said, but failed to improve it, finally leaving for London. To assure ourselves that the batteries and line were in good order, a United Telephone Company's set was placed side by side with switches to cut in either set of instruments; and, whilst the Bell-Blake gave good results (as did also a Gower-Bell), the others remained in the same unsatisfactory condition, described by an experienced electrician as "Punch and Judy talk." Need I add the result, viz., that whilst the order for new telephones was forwarded to London, it was not addressed to the New Telephone Company, Limited. I therefore consider that since a diaphragm acts so well in the Blake, and the want of it is so apparent in the instruments referred to, the point to be aimed at is to get an efficient transmitter, which yet is clear of the "combination" of a "diaphragm with a current regulator."

Combination.

February 27th, 1886.

With reference to the letter on the above subject in your issue for Feb. 19th, it would be interesting to know what "Combination" means by the term *current generator*.

An ordinary Bell telephone when employed as a transmitter, generates its own currents, or more accurately speaking, converts the energy exerted by the speaker and communicated through the medium of the atmospheric sound waves to the diaphragm, into electric currents, but anything of this nature would obviously be subject to the Bell patent.

Moreover, magneto transmitters are not sufficiently powerful to be of commercial utility, and your correspondent himself admits as much.

In Edison's specification No. 2909, 1877, will be found a description of a transmitter operated by the vibration of a diaphragm of vulcanite in proximity to the face of a thermopile, but it is most doubtful if ever passable results could be obtained with an instrument on this principle, even under the most favourable circumstances, in consequence of the extremely low E.M.F. developed by thermo-couples, and the slow action of all thermic effects.

Bréguet's capillary telephone is also the combination of a diaphragm with a current generator, and there are others of a similar nature; but I have, I think, said enough to prove that your correspondent's suggestion is scarcely so fresh a departure as he apparently imagines.

While on this topic, allow me to express a hope that you will see your way to give as full a report of Mr. Justice North's judgment in the "Bassano" case, which I see is now shortly to be published, as you gave of the proceedings of that very interesting trial.

"Telephonist."

February 28th, 1886.

Secondary Batteries as Regulators.

It has at various times been stated that the most perfect regulator one can have to correct the disadvantages brought about by irregular motive power, is a secondary battery of suitable size, coupled in parallel with the dynamo. This statement is no doubt, broadly speaking, true, but it has been my experience that under certain circumstances the secondary battery does not absorb the excess of current produced by an irregularly driven dynamo; it is, on the contrary, forced through the lamps, causing them to pulsate in time with the variations of speed of the dynamo.

The phenomenon, however, only occurs when the amount of current being discharged exactly equals the average charging current. In my case, an ammeter inserted in the charging current circuit oscillates between 45 and 55 ampères; as the discharge approaches 50 ampères this variation decreases, and when the discharge reaches 50 the ammeter needle steadies considerably, but still oscillates to the extent of one or two ampères; at this moment the E.M.F. drops about 5 per cent., the variation of current indicated by the ammeter is forced through the lamps, and a most disagreeable pulsation commences.

Immediately the discharging current decreases or increases, the E.M.F. recovers; the ammeter shows the usual oscillation, and the lamps burn as steadily as can be desired.

If any of your readers will advise me as to the best method, if any, of overcoming this difficulty, I shall be obliged.

Aug. J. Littleton.

Sydenham.

Incandescent Lamps as Telephones.

In the course of Prof. Dolbear's lecture on the telephone, printed in your issue of February 19th, reference is made to the fact that an ordinary incandescent lamp will act as a telephonic receiver.

I should be much interested to learn when, and by whom, this was discovered in America, for I constructed receivers on this principle as far back as the spring of 1882. Later in the same year, I also found that a Leyden jar, likewise referred to in the lecture, would receive. I communicated my discovery regarding the incandescent lamp to Mr. G. J. Somerville at the time it was made, who, I find, not only recollects the circumstance perfectly, but made a note of it in his memorandum book. The fact was also known to a workman who assisted me with the experiments. In corroboration of the Leyden jar discovery, I may mention that Messrs. Woodhouse and Rawson made me, for experimental purposes, twenty special Leyden jars, which they knew by the name of "vacuum condensers." I have occasionally mentioned to my friends—Colonel R. R. Jackson amongst others—that I was in possession of a novel telephonic receiver, but without (except in Somerville's case) making known the principle, for I was not without hopes of eventually evolving a practical telephone. Pressure of business has compelled me to let the matter lie for the last three years, but I believe this could be done if earnestly gone about.

A. R. Bennett.

90A, George Street, Edinburgh,
March 1st, 1886.

A Telephone Conference.

I have spoken to a considerable number of gentlemen of many nationalities interested in the telephone, *but outside the monopoly*, as to the advisability of holding a conference in London or Paris, to discuss the telephone in general, investigate claims, and consider what steps, if any, it will be advisable to take to protect the public and the electrical profession against the present monopoly, and all agree that such a conference is most desirable, and have promised to give it all the support and assistance in their power. As it is impossible to communicate or see everyone personally, I shall be glad to receive a line from all who are willing to assist with advice or information, or who would be desirous of attending the conference. Suggestions will be thankfully received.

W. E. Irish.

Rosemount Lodge, Richmond, Surrey,
1st March, 1886.

FitzGerald Secondary Batteries.

The statement quoted from the *Electrical Engineer* in your last issue (p. 194) that M. Hospitalier had written a report upon this battery (from whatever source it may have been obtained) is incorrect. I have been present at most of the experiments made, and am fully cognizant of what has taken place. A first battery was tested in June last by M. Hospitalier, a second test took place in October, a third on the 15th and 16th December, and a fourth on the 23rd and 24th December, this last one with a rate of discharge of 22 ampères. No report, however, was given by M. Hospitalier, and no one is authorised to state that the report of the tests is or will be favourable. It is not probable that M. Hospitalier will give his report until two more electricians, one English the other French, have tested again the batteries which lay idle at the laboratory of the Eish Municipale de Physique et de Chimie Industrielles, in Paris.

The *Electrical Engineer* will not be surprised that the proprietors of the FitzGerald battery *have shown their battery in France with a view to its being reported upon by a French savant*, when he knows that the Continental patents for this battery were offered for sale many months ago in Paris, where the intending purchasers are quite entitled to have the experiments conducted by their own tester.

The few persons who were present at the experiments were allowed, by the kindness of M. Hospitalier, to have a copy of the readings, but none of them were authorised to make use of the figures or to publish the results obtained, and the only thing I would say at present is, that on the 24th December, 1885, the rate of discharge was 22 ampères, and that it is intended to run a battery next time at the rate of 40 ampères.

A. F.

Spiel's Petroleum Motor.

I notice in a recent issue of the ELECTRICAL REVIEW an article on "Spiel's Petroleum Motor," and should feel obliged if you would send me the address of the agents or makers for this country.

Thanking you in anticipation,

George R. Cook.

Club Garden Road, Sheffield,
February 27th, 1886.

[Spiel's petroleum engine is being introduced in this country by Messrs. Crozier & Co., of 1, Leadenhall Street, E.C.—EDS. ELEC. REV.]

New Pattern Reversing Key for Single Needle Instruments.

Upon page 64 of Williams's "Manual of Telegraphy" (lately issued), is an engraving of a new pattern reversing key. I should feel obliged if some one will tell me how to connect it up with a pair of needle instruments on *open* circuit. With the connections as per instructions given with the engraving, the circuit is only complete when the current from the sending station passes through the battery at the receiving station. This, I feel sure, should not be. A rough sketch will oblige

"Perplexed."